AD/A-006 900

NEW APPLICATIONS FOR ARPANET DEVELOPED INFORMATION
PROCESSING TECHNOLOGY. VOLUME I. ON THE AUTOMATION
OF THE PROCUREMENT PROCESS: PRESENT STATUS, FEASIBILITY
FOR IMPROVEMENTS, PROPOSED NEXT STEPS, AND PAYOFFS

CABLEDATA ASSOCIATES, INCORPORATED

PREPARED FOR
AIR FORCE EASTERN TEST RANGE
ADVANCED RESEARCH PROJECTS AGENCY

3 FEBRUARY 1975

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER R-170	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER AD/A- C.C. 900
4. TITLE (and Subtitle) NEW APPLICATIONS FOR ARPANET DEVELOPED INFORMATION PROCESSING TECHNOLOGY -- VOLUME I: "ON THE AUTOMATION OF THE PROCUREMENT PROCESS: PRESENT STATUS, FEASIBILITY FOR IMPROVEMENTS, PROPOSED NEXT STEPS, AND PAYOFFS"		5. TYPE OF REPORT & PERIOD COVERED Final Report February 1974 – January 1975
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Carson E. Agnew, Paul Baran, David C. Caulkins, Vinton G. Cerf, Ronald C. Crane, Edwin B. Parker, and Marc U. Porat		8. CONTRACT OR GRANT NUMBER(s) F08606-74-C-0043
9. PERFORMING ORGANIZATION NAME AND ADDRESS Cabledata Associates, Inc. 701 Welch Road Palo Alto, CA 94304		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PROGRAM CODE # 4P10 ARPA Order 2317/2
11. CONTROLLING OFFICE NAME AND ADDRESS Advanced Research Projects Agency 1400 Wilson Boulevard Arlington, VA 22209		12. REPORT DATE 3 February 1975
		13. NUMBER OF PAGES 112
14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office) Range Measurements Laboratory (ENL) Air Force Eastern Test Range (AFSC) Patrick Air Force Base, FL 32925		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution unlimited. Available from National Technical Information Service, Springfield, VA 22151.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, If different from Report)

PRICES SUBJECT TO CHANGE

18. SUPPLEMENTARY NOTES

-----

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer Networks, Cost-Benefit Analysis, Office Automation, Defense Procurement, Procurement Automation, Intelligent Terminals, Procurement Management, Automation Economics, Computer Secrecy Protection, Communications, ARPANET.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Explores new applications for transfer of technology developed by ARPA/IPTO. Discusses technical and economic feasibility of widespread computer-netting technology to aid DoD procurement effectiveness. Describes procurement automation system development, the software and hardware required, and provides a hardware configuration. Details logical next steps in a procurement automation system. Provides cost-benefit analysis and a survey of procurement automation systems presently in use. Shows that savings in excess of $1 billion per year might be achievable in the future.

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE

This report is intended to be read at
several levels. If you are interested only
in a broad overview of its contents, we sug-
gest that you read the Executive Summary,
pp. 1-15. For more detailed reading, consult:

Volume I, ON THE AUTOMATION OF THE PROCUREMENT
PROCESS: PRESENT STATUS, FEASIBILITY FOR IMPROVE-
MENTS, PROPOSED NEXT STEPS, AND PAYOFFS, reports our
findings on the areas studied under this contract.
We believe that over $1 billion can be saved each
year (primarily due to improved competition) by the
application of information technology to large sys-
tems procurement. These savings can be achieved
using known techniques and advanced systems. How-
ever, a prerequisite to their application is a com-
mitment by DOD to procurement automation.

Volume II, SECURITY IN THE AUTOMATED PROCUREMENT
PROCESS; SECRECY VS FREEDOM OF INFORMATION VS EFFI-
CIENCY: A LEGAL ANALYSIS, forms a background appen-
dix to the first volume. It addresses the changed
legal and political environment in which the future
procurement automation system must exist and sets the
ground rules for secrecy and privacy protection guide-
lines.

To avoid duplicating material contained in
other publicly available reports, we are enclosing
the Table of Contents of the two Interim Technical
Reports that formed the basis for this Final Report,
as Appendix B to Volume I. The two Interim Technical
Reports are available from the National Technical In-
formation Service, as follows.

AD 783508, ARPANET MANAGEMENT STUDY: NEW APPLI-
CATION AREAS, First Quarterly Techni-
cal Report, Cabledata Associates
Report No. R-148, 5 May 1974.

AD 787039, ARPANET MANAGEMENT STUDY: NEW APPLI-
CATION AREAS, Second Quarterly Techni-
cal Report, Cabledata Associates
Report No. R-160, 5 August 1974.

i

CONTENTS

Contents (Continued)

Contents (Continued)

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

CHOICE OF APPLICATION AREA

The charter for this work specified a search for new areas
in which ARPA/IPTO technology can be successfully transferred
to other areas of DoD. We sought not to examine procurement
automation per se, but selected this subject only after
a systematic search, starting with an examination of the entire
Defense budget. We considered major categories of expenditures,
labor categories, and the information processing needs for some
of the major cost categories. Large scale procurement had all
the characteristics that made it worthy of careful, detailed
examination. Not only were there very large dollar savings
(perhaps $1 billion/year) that could be made here, but
there would be major increases in effectiveness and other bene-
fits not readily quantifiable. However, achieving successful
automation of large procurements is not at all a straightforward
activity. To gain the full benefits possible, it is going to
be necessary to further advance the state of the art of large
multi-user computer netted systems. And, it will be necessary
to restructure and rationalize the entire defense procurement
process.

As this became a much larger challenge than we anticipated
at the outset of the project, we chose to focus our limited
resources on this single subject area in depth, rather than
investigate a larger number of other smaller domains for new
applications for computer netting.

At the outset of our investigation, we took some time to
find out how large scale procurements really worked in practice,
in contradistinction to the neat formal way described in

1

the regulations. These differences are not insignificant. We seek to address the reality within, as far as possible, the statutory constraints.

Procurement may seem to be a little removed from information processing, but it has many characteristics in which we could envision important gains by an effective technology transfer of the new computer resource sharing technology, using computer netting.

Consider the following general characteristics of the procurement process.

1. The activity is <u>large</u>. Procurement represents the largest single item in the Defense budget, $45 billion/year. But, 81% of these dollars are involved in procurements which comprise only 1.7% of the total number of procurements conducted each year. Most of these large procurements are awarded on a non-competi- tive basis. In addition to the cost associated with procuring these items, there is a cost iceberg which multiplies the effective cost of conducting a procure- ment several times over. Components of these costs include costs from procurement delays, failure to use the latest technology, and from the lack of competition cr interest in government business.

2. It is <u>labor intensive</u>. DoD procurement requires large use of expensive manpower. Of the 62,000 procurement positions, almost 17,000 are in the middle management grades GS-11 through GS-13. The DoD procurement payroll alone is $732 million in direct costs and possibly $2 billion or more if indirect costs are included. Eclipsing labor costs are potential sub- stantial improvements in effectiveness of the procure- ments that could be effected by improvements in produc- tivity of procurement staffs.

3. Procurement is an <u>information intensive</u> activity. The effective management of the procurement budget requires the collection, storage, processing and dissemination of large amounts of information. The very costliness of this presently manual process leads to contracting deci- sions at variance with general public policy considera- tions. For example, management must award a few large contracts instead of many small ones, to ease the burden on its limited staffs. While saving some management labor, this serves to act as a barrier to entry. The market for government contracts is constrained in choice by the increased minimum size which a firm must attain in

order to handle the contracted work.

Delays in the information flow and difficulties in
coordination often result in uncertainty for both sup-
pliers and buyers. This in itself can lead to costly
and inefficient behavior -- all of which the government
must pay for, one way or another. As will be shown,
substantial benefits are potentially achievable through
the use of automation. In essence, by reducing "inform-
ation costs," we shall show that we can increase effec-
tive competition, with resulting savings.

4. Timing. National and congressional concern over
procurement is at an all-time high and probably will be
increasing further. Because of the increased pressures
to skimp on the Defense budget, changes in procurement
procedures in the institution of cost saving methods are
more likely to be acceptable now than at any time in the
last thirty years. Society is now placing more emphasis
on openness in government activity. Procedures which
fail to convince the public and the congress of their
fairness and openness may be expected to be replaced.
And, lastly and most importantly, the technology to sup-
port this form of automation has only recently become
mature.

THE CURRENT STATE OF PROCUREMENT AUTOMATION

Automation efforts for procuring small or routine orders are
well advanced and are already making good use of existing technol-
ogy. However, in that sector where most of the defense dollars
are spent, the full benefits that automation could bring are yet
to be fully felt. And, here is where we have focused our atten-
tion.

Initially, we surveyed ten systems within the Department of
Defense, as well as several maintained by other government agencies,
each of which is used in automation of parts of the procurement
function. Some were mature and fully operational, while several
will be implemented during 1975. Most systems are used in the
routine procurement of small quantities which can be conducted in
a highly standardized fashion. With the smallest items, those
under $250, the process of procurement automation in this form is
almost complete. As the dollar value of the procurement increased,

3

we found a progressive reduction in the level of automation.
This shift was simply that non-routine procurements were more
difficult to automate than present systems allow. It is these
large "systems procurements" that are the sector of our interest.
Generally, these entail items involving high costs, high technol-
ogy, or high risks. Such procurements accounting for most
dollars are conducted by DoD in a largely manual fashion today.
They require a great deal of individual coordination, multiple
level approaches, political decisions and exercise of judgment.

PROCUREMENT IN THE 1980s

Objectives

In this report we limit our consideration of automation
solely to those components that do not require the exercise of
judgment. Rather, we show that more time can be available for
thinking if we can reduce much of the routine unthinking paper-
work required by the nature of very large organizations. As a
goal, we believe that it will be possible by the early 1980s to
create and implement the use of new information processing tools
for effectively aiding those involved in the automation of the
large procurements. This will be accomplished not by making
them routine, but by augmenting the ability of human beings to
deal with complicated non-routine problems. The automated pro-
curement system of the future will require widespread access to
large on-line databases, and an integrated family of general office
automation on-line tools. And, it will require the ability to
manipulate files to monitor the current status, past performance
and costs of specific procurement actions. The general design
objectives of the system include:

- o Eliminating paperwork in favor of electronic storage
  and processing.

- o Facilitating the parallel processing and electronic
  transfer of documents, rather than their serial pro-
  cessing and manual transfer.

- o Maintaining and monitoring user access to the subsystems,
  protecting proprietary and classified information. But,

4

simultaneously permitting better public access for open files in close conformity with the Freedom of Information Act.

o Facilitating the preparation of reports and forms by automatic inclusion of previously drafted or reported material.

o Highlighting the problem areas of a procurement for human intervention, while leaving the routine document processing to an automated system.

These objectives are more easily stated than accomplished. Improvements in the state of the art generally believed to mature within the next five years, together with a research and design effort tailored to the needs of procurement automation should permit achievement of these objectives. More detailed and concrete support for this view will be found in Section 2, SYSTEMS DEVELOPMENT, and elsewhere in this report.

A system to save $7/hour labor at a cost of $30/hour requires overall user effectiveness increases much greater than is generally possible with the new capabilities provided. But, on the other hand, we can find domains for significant savings at the $3/hour level. Ignoring the issue of new system capabilities such as better cryptographic protection than exists today, the job of reducing overall cost by ten-to-one is neither easy nor straightforward. It will require research and development, and new hardware and software designs. We describe this elsewhere in this report. And we shall show that the full system we shall need will probably have an annualized cost of about $45 million per year. But, let us for the moment defer the details of the missing pieces and costs and consider what the payoffs for such a system might be in the 1980s.

BENEFITS: $1 BILLION/YEAR

Appendix A provides a detailed benefits analysis of our present estimates of the annual value of the tangible component of savings which could be realized by the automation of systems procurements. Table 1 summarizes these savings into four components. The reader is urged to read Appendix A carefully for the assumptions contained in these estimates.

5

TABLE 1

TOTAL TANGIBLE SAVINGS

o	IMPROVED COMPETITIVE MARKETPLACE	$ 778 M
o	EARLIER USE OF LATER TECHNOLOGY	193 M
o	REDUCED PROCUREMENT DELAYS	124 M
o	LABOR SAVINGS	77 M
	TOTAL:	$1,172 M

In addition to the tangible benefits discussed above, there are other, intangible benefits. These include:

o Increases in the span of control and flexibility of procurement management.

c Improvements in response time for emergency procurements.

o Improvements in the planning and scheduling ability of government and private industry.

o Increased openness in procurement through the use of audit trails and other recordkeeping procedures.

o Better responsiveness to congress and higher levels of Department of Defense management.

Below we briefly consider the nature of the tangible savings.

Improved Competitive Marketplace Savings

Of the $1.172 billion in benefits, the largest component is attributable to an increase in procurement dollars diverted to the domain of competitive enterprise in lieu of sole source. Today, only forty-five per cent of all procurement dollars are spent in the competitive sector.

Recent congressional studies* (together with independent judgments on this subject from a number of students of defense

----

* Commission on Government Procurement, *Report of the Commission on Government Procurement*, 4 vols., Washington, D.C.: U.S. Government Printing Office, 1972.

6

procurement, including Admiral Hyman Rickover)* suggest the
magnitude of savings from competitive, in lieu of sole-source,
procurements. While competitive bidding is preferred national
policy,** the present procurement system carries an information
burden so large that it can most easily manage only a limited
number of large contracts. That these awards need not be large
can be appreciated when one realizes that over fifty per cent of
the dollar value of a systems award is then subcontracted out
anyway. The automated system which we have discussed is designed
to reduce the cost of information processing by automating the
processing of routine information and by augmenting the capability
of those involved in procurement activities. As a result, the
procurement automation system will make it possible for DoD to
reduce to a degree the necessary scale size of procurements.
These smaller procurements tend to lower the minimum effective
size which a firm must have in order to bid. This not only elimi-
nates the monopoly held by contractors in specialized areas, it
also will help to smooth the flow of orders to all companies,
large or small. These changes in the market for government
business would result in lower costs to the government.

Earlier Use of Later Technology Savings

The second component is savings due to the use of more
recent technology. A procurement system that permits you to
order and receive an electronic hand calculator today, if you
want it today, instead of having to order it two years ago, using
the then available technology, represents a saving. This is

----

*Hearings Before the Subcommittee on Priorities and Economy
in Government, Part 7, Washington, D.C.: U.S. Government Printing
Office, 1974.

**"The unrestrained interaction of competitive forces will
yield the best allocation of our economic resources, the lowest
prices, the highest quality, and the greatest material progress,
while at the same time providing an environment conducive to the
preservation of our democratic political and social institutio ."
                                            -- U.S. Supreme Court, 1967.
            (Reference: Communication News, November 1974, p. 30.)

because of the rapidly diminishing cost of integrated circuit technology. While such savings occur only in very few high technology areas, the DoD tends to procure a surprising amount of such cost-declining high technology equipment where this phenomenon occurs. Most savings are in procurements involving substantial amounts of integrated circuitry, particularly digital circuitry.

Reduced Procurement Delays

There are really two components of savings due to shortened procurement delay. We have briefly described the first -- cost-declining technology. In the present category we speak of the "pipe-line carrying charges." Here, reduced procurement delays can be valued somewhat in the same way that a private firm values an improved inventory system -- by the interest saved on the opportunity cost of the money which would have been tied up had the delay not been reduced.

Labor Savings

We have two options to consider in connection with the use of the potential cost benefits of impoved labor efficiency. Initially, we considered connecting savings into reduced number of personnel. But, after computing the size of the savings that could be realized by having the present work force do more, rather than less, it is our belief that it would be false economy to use the increase in effectiveness to merely reduce the numbers of people involved in the procurement process. There are larger savings to be captured by making the system more efficient.

COSTS AND COST BENEFITS

We consider the subject of detailed costs elsewhere in this volume.* In brief, we shall need a new automated system costing on the order of $45 million per year,** giving us an estimated benefit-to-cost ratio in excess of 20:1.

----

*Appendix A.

**Ibid, pp. A-20 through A-22.

Any estimate, particularly considering a domain as large
as the $45 billion annual procurement budget, is certain to be
off the mark by a wide margin. Finer grain analysis is, of
course, desirable. But, for our purposes, it is sufficient to
know that these savings are so potentially large in comparison to
costs, suggesting that we can be off by a large amount without
altering the conclusions: further investigation in this sub-
ject area should be given high priority in defense computer
automation planning.

PLANNING FOR TRANSITION

We have to consider the number of presently operating com-
puter based systems that are used in one way or another in the
automation of some procurement activities. Systems are rarely
effectively specified unless due consideration is made of other
existing and planned systems that must interface with the system
design proposed. Interface specifications are most effectively
considered well before the date of anticipated interconnection,
to assure that no irreversible decisions are made that increase
the cost or difficulty of later interconnection.

In the process of creating a list of the areas of organiza-
tion, software and hardware which we thought were essential to a
complete procurement system, we found that planning or implementa-
tion was well advanced in some areas, while in others it was not
yet begun. In several areas, the need for considerable further
effort was evident.

Recognition of Problem

DoD has shown a clear recognition that procurement is an
area subject to improvement by present efforts in automating the more
routine procurement and contract administration activities. How-
ever, there are several sub-areas where DoD's attention is required.
First, there is a need for developing comprehensive interface
standards between the various branches of DoD, and between DoD
and its contractors, which will facilitate the exchange of inform-
ation by automated systems. DoD has begun the inter-branch definition

9

of standards via the MILSCAP directive of 10 January 1968. A high level commitment to this effort is required if the final procurement automation system is not to be unnecessarily limited by incompatible standards.

Similarly, we see a need for a commitment to the effective implementation of networking and resource sharing at the operational level in DoD. The absence of a fully suitable communications network in being today dampens both the designer's and the user's propensity to plan in terms of a large distributed DoD-wide system. While the ARPANET forms an excellent early model for such a network, the lack of an operational network with the desired properties serves as an impediment to serious thinking about widespread computer netting by operational agencies. Similarly, resource sharing between computers, demonstrated by IPTO, is another missing piece. Although preliminary work has been completed and general research continues, this technology still is not quite ripe enough. Agreement is needed on hardware specifications and protocols to facilitate the interchange of large files. Lastly, we have not resolved organizational structure issues which would make it possible for a manager to share his resources willingly with the manager of another facility. Such problems will not be solved overnight. But, there is a challenge here to prepare for new computer system architecture now, by planning for and fostering it in such a way that management accepts it when it becomes available.

The last requirement, which we feel is extremely important, is the need for an overall plan for the architecture of the final system. Current DoD planning in computer automation has tended to be bottom-up in nature, and the benefits of bottom-up design diminish rapidly as the system expands. The time has come for a comprehensive master plan to accommodate small discrete pieces of the operation and coordinate their development among the various branches of DoD.

IMMEDIATE NEXT STEPS

This study of procurement automation was a preliminary
investigation. It was not intended to be either complete or
definitive. Thus, there are more unanswered questions facing
us now than at the outset of this study. The key difference is
that we now know the questions that we should ask. And, at
this point we believe that there are three topics of paramount
importance that form reasonable next steps to permit getting on
with this development. These involve analysis, systems integra-
tion, and system synthesis. Details of these steps are described
elsewhere in this report and in previous interim reports.

Analysis

More knowledge is needed about the workers in the procure-
ment labor force. Effort should be directed at developing time
budgets for procurement personnel in order to explore the feasi-
bility of automating specific clerical tasks. A series of user
profiles and activity time/cost profiles would enable us to deter-
mine which early capabilities of procurement automation would have
the best payoff, and the best chance of gaining acceptance within
the existing system. The question we seek to address is that of
determining the true degree of labor savings as a function of
computer automation.

System Integration

We need to describe much more precisely the hypothetical
endpoint system discussed in this report. In addition, we shall
need a plan for integrating this system with other procurement
automation systems. These two requirements call for a detailed,
long range plan and require a better understanding of DoD's pro-
curement operations and a better understanding of the technology
that would be used to bring automation about.

System Synthesis

The automated system itself must be synthesized in more
detail than was done in this report. We should:

1. Determine the first-cut set of user software
applications -- text editors and database
maintenance programs.

11

2. Perform a first-cut system design.

3. Estimate response times for various user loads.

4. Evaluate the procurement automation system hardware configuration using a multiprocessor throughput model.

5. Determine the division of tasks between user terminals and procurement automation system centers.

6. Perform a first-cut design of the intelligent terminal to be used with the procurement automation system.

7. Perform a first-cut design of the communication system and its protocols.

These operations in turn will direct our attention to possible gaps in our technology, and will help to determine the order, scope and timing of procurement automation.

Research Components: Missing Pieces

One question that naturally arises is, why not assign the work directly to an operational agency and let it get on with the task of specifying and proceeding with a complete system design? The reason, as described earlier, is that there are simply too many pieces that will require research.

Consider the following: many, or even most of the capabilities we describe can in fact be demonstrated in primitive form in the near term. The problem is not in demonstrating that it can be done, rather it is that of lowering costs and improving performance by innovative design, plus research, plus a very good understanding of what is really needed.

Remote time-shared systems in the $30+/hour range exist today for handling moderate size data bases. The necessary cost per hour for this system is on the order of $3/hour,[*] a factor of 1/10th, plus greater capabilities in a number of system sectors (described elsewhere in this report) including:

1. Communications networks. The ARPANET packet switching technology is ideal here. But, other than experimental networks, a full network of the desired size does not yet exist. Expectations for its availability in the time period of interest are excellent.

---

[*] The $/hour cost estimate for the system described later in this report is $2.74. See p. A-20, Appendix A.

12

2. Low cost smart terminals. This system will require
very large numbers of simple, low cost intelligent termi-
nals. Low cost (on the order of $1000 per terminal) is
required for widespread access; local processing is re-
quired to tailor the inexperienced user interface (invisible
to the user) to the overall system interface, to reduce
the load on the central processor, and to aid user authen-
tication and file protection.

3. Large multiprocessor. The system will need to support
about 22,000 terminals with an estimated peakload of 11,000
simultaneous users in the configuration considered. On the
basis of eleven centers (for survivability and reliability
considerations) this means that each multiprocessor system
must handle 1000 simultaneous users. We show a first-cut
design for such a system in this report (page 43). Since
such systems do not exist today, design and evaluation work
is clearly needed.

4. Large memories. This system is predicated on the exis-
tence of a hierarchy of memories. These extend from a multi-
port high speed main memory able to handle about fifteen
simultaneous user jobs, through very high bandwidth swapping
disks to large intermediate storage to very large archival
files. The first-cut design pushes the 1974 limites at each
level of the hierarchy. Very effective software will be re-
quired to provide user service without delays. Improved
memory capability will be highly desirable here, but the
present state of the art need not stop system development.

5. Multi media conferencing. To permit effective communi-
cations among geographically distributed individuals in-
volved in major procurement requires the ability to effec-
tively conduct meetings using electrical communications in
lieu of physical travel. Some work has been done on com-
puter terminal conferencing, some on voice conferencing.
Additional work, particularly on improved human factor inter-
faces, would be helpful and is needed here, together with
inclusion of other media, such as band compressed video,
facsimile, and electronic chalkboards.

6. Graphical input/output devices. The fullest develop-
ment of a procurement system requires handling line draw-
ings. While facsimile input and output is possible,
storing, retrieving and transmitting in such form does not
make efficient use of the communications channel and the
digital memory subsystems. More effective data compression
techniques, designed specifically for line drawing applica-
tions, have payoff and would be useful.

7. Text reader input/output. During the early era of
procurement automation, much input will be in the form of
typewritten or printed text. OCR machines exist today able
to adapt to uncontrolled multiple fonts.

13

Unfortunately, their error rates are still unacceptable.
A long range standard for interim input formats would be
useful, but will require an appreciation of the present
state of the art of readers, anticipated state of the art,
and an understanding of forms, databases and procedures
necessary in procurement automation. Also useful would be
development of better input mechanisms.

8. Software. Of all the missing pieces, none is so ob-
vious as the specialized software required. As this des-
cription is lengthy, we leave it for discussion elsewhere.
Essential software system building blocks needed are des-
cribed in Section 2, SYSTEM DEVELOPMENT.

INSTITUTIONAL CHANGES

There are two sets of institutional changes that were con-
sidered in this study. The first are the changes in the insti-
tution of procurement caused by the changes in technology envision-
ed. For example, the new capability permits creation of a more
efficient management structure. The extended effective span of
management control allows greater overall centralized control
simultaneously with an increasingly decentralized manpower organi-
zation.

The second type of institutional changes that we consider
are those attributable to a modified political and social en-
vironment in the era in which the automated procurement system
must live.

In particular, we have explored three changes in this environ-
ment that affect systems design. First, there is the implication
of an expected long term diminishing percentage of GNP allocated
for Defense purposes.*

The second change considered is the implication of a broad-
ened Freedom of Information Act and the resulting opening of
almost all governmental expenditures and contractor selection
decisions to greater, more detailed public and congressional

----

*This is described briefly herein (Section 2, pp. 48-50) and
in Appendix G of the First Quarterly Technical Report, *ARPANET
MANGEMENT STUDY: New Application Areas*, Cabledata Associates
Report R-148 (NTIS #AD 783508), 5 May 1974.

scrutiny.[*]   Also discussed is the finding that significantly
less reliance can be placed on the use of national security sec-
recy sanctions within the future procurement system. As a prac-
tical matter, it is shown that such sanctions, even against fla-
grant violations of the secrecy acts, are ineffective. The remedy
is so toothless that most classification efforts will probably be
self-defeating.[**]   Almost paradoxically, there will be an in-
creasing need to protect personal files and company proprietary
information within this system.[***]   The subject of hardware and
software means for obtaining secrecy and privacy protection with-
in this system has been discussed in the interim reports.[****]

----

[*] See Section 2, p. 50. Also, Appendix G of the First Quarter-
ly Technical Report, *ARPANET MANAGEMENT STUDY: New Application
Areas,* Cabledata Associates Report R-148 (NTIS #AD 783508),
5 May 1974.

[**] Volume II of this report is devoted to a detailed treat-
ment of this important issue.

[***] See Section 3, p. 58.

[****] See Appendix D of the Second Quarterly Technical Report,
ARPANET MANAGEMENT STUDY: New Application Areas, Cabledata
Associates Report R-160 (NTIS #AD 787039), 5 August 1974

1. INTRODUCTION

OBJECTIVE

This report summarizes a one-year study by Cabledata Associates
directed toward finding applications and ways to aid the technology
transfer of the computer netted system development sponsored by the
Information Processing Techniques Office of the Defense Advanced
Research Projects Agency to unmet needs present in the Department
of Defense.

TECHNOLOGY TRANSFER

Our primary interest is in seeking applications for technology
still in the laboratory stage. Thus, this volume deals primarily with
the subject of technology transfer. It will be of primary interest to
those who are in a position to improve the defense procurement process.
It is thus addressed to defense policy makers within the Department of
Defense and the Congress, and to computer technologists who will have
to advance the art if the payoffs possible are to be turned into reality.

The effectiveness of federal research is being increasingly ques-
tioned. Study after study suggests that the lack of payoff results
most often from the institutional boundary between the research environ-
ment that demands novelty and the domain of operations that cannot afford
the risk of untried technology.* Effective technology transfer seeks to
shorten the time to application in better using benefits of already com-
pleted research, and to create a better guidance for new research. Given
enough time the development would eventually be used anyway, but a very
high price is paid for lack of capability for the decade that can pass
from the time that a new technology is feasible and the time that it is
effectively used.

----
*
*TECHNOLOGY TRANSFER AND UTILIZATION: Recommendations for Redirecting
the Emphasis and Correcting the Imbalance,* National Academy of Engineering,
prepared for National Science Foundation, February 1974. (Available from
NTIS as #PB-232 123.)

What we have sought to accomplish in this present work is to provide a bridge for technological transfer of some computer netting research into fitting a major defense need -- improving the procurement process. In the present case we face two hurdles; some missing technology plus lack of a single focus of responsibility capable of all forms of the following elements necessary to convert a possibility into a reality:

o research and development
ᴐ computer and communications systems implementation
o procurement policy
o procurement operations

The present effort by Cabledata Associates is unique in that it went far beyond the limited confines of addressing more than a single part of this problem under normal research charters. But there is a problem at this point. There is no single "customer" for this work with the complete responsibility for the next steps. Thus, while we shall show that the potential for savings found is huge -- possibly over $1 billion annually -- if we have to make book on the outcome of this activity, our expected conclusion is that the findings will most likely drop in the crack between organizational responsibilities and further examination of this area will be deferred indefinitely. As a minimum, this report may represent an interesting case study of the need for institutional reform in one major sector of defense expenditures -- the procurement process -- if the possible economic benefits of governmental investment in research is to be turned into reality.

REASONS FOR SELECTION OF PROCUREMENT AS A DOMAIN FOR COMPUTER NETTED AUTOMATION

The reasons for selecting procurement are several. It is the largest single expenditure item in the Defense portion of the Federal budget. And, procurement is primarily information processing in nature, requiring coordination of geographically distributed offices. In short, its needs come close to matching the new capabilities wrought by computer resources using packet switching.

Table 2 lists major DoD budget items representing expenditures of $500,000,000 or more in order of size.

TABLE 2

DoD BUDGET - MAJOR CATEGORIES

Item	Amount ($x10^9)			%			
	'73	'74	'75	'73	'74	'75	Page*
Procurement	18.57	18.55	19.87	21.6	21.1	21.0	289
Industrial Funds	8.83	9.25	9.54	10.3	10.5	10.1	342
Research, Development, Test & Ev.	8.11	8.30	9.30	9.4	9.4	9.8	312
Army Personnel	7.79	7.78	7.98	9.1	8.8	8.4	266
Air Force Personnel	7.40	7.49	7.50	8.6	8.5	7.9	269
Air Force Operation & Maint.	7.15	7.21	8.14	8.3	8.2	8.6	280
Army Operation & Maint.	7.90	7.60	8.03	9.2	8.6	8.5	277
Navy Operation & Maint.	6.00	6.89	7.93	7.0	7.8	8.4	278
Navy Personnel	5.50	5.74	5.81	6.4	6.5	6.1	267
Military Construction	1.46	1.82	2.15	1.7	2.1	2.3	320
Marine Personnel	1.59	1.68	1.74	1.8	1.9	1.8	268
Defense Agencies, Oper. & Maint.	1.51	1.69	2.10	1.8	1.9	2.2	282
Corps of Engineers	1.95	1.66	1.62	2.3	1.9	1.7	357
Family Housing	0.86	1.12	1.29	1.0	1.3	1.4	330
Army Nat. Guard, Oper. & Maint.	0.45	0.55	0.61	0.5	0.6	0.6	286
Air Nat. Guard, Oper. & Maint.	0.47	0.54	0.61	0.6	0.6	0.6	287
Marines Operation & Maintenance	0.44	0.48	0.51	0.5	0.5	0.5	279
Totals	85.98	88.45	94.78	100	100	100	

* Source: *Appendix to the Budget of the United States Government, Fiscal Year 1975.*

It can be seen that procurement expenditures are twice as large as the next largest item and comprise 21% of the DoD budget. Because of its sheer size and nature, considerable absolute savings could be realized if even a little effort is saved in each procurement as a result of applying computer network automation to the procurement process.

What Is a Typical Procurement?

When the total dollar volume of procurement is broken down by size, a not commonly appreciated pattern emerges. Table 3 lists the FY1973 experience with procurement by the type of award.

TABLE 3

FISCAL YEAR 1973 PROCUREMENT
BY TYPE OF AWARD

Category	Amount (million $)	Number (thousand $)	Average value ($)
Intragovernmental	3,038	744	4,083
Under $10,000	3,652	9,578	381
Over $10,000 (subtotal)	29,913	177	169,000
Fixed price	20,752	154	134,750
Cost reimbursable	8,923	20	448,400
Other	238	3	79,300
Total	36,920	10,499	3,517

Source: Office of the Assistant Secretary of Defense (Comptroller), *"Military Prime Contract Awards and Subcontract Payments or Commitments - July 1972 to June 1973,"* Table 16.

Of a total of $37 billion,* $30 billion involved procurements whose value was more than $10,000. However, these procurements comprised only 177,000 of the 10,499,000 procurement actions which took place during the year. That is, about 1.7% of all procurement actions had an average value of $169,000, although the overall average procurement in 1973 had a value of only $3517.

----

*The $36.920 billion estimate here fails to match the $18.57 billion in Table 2 because other line-items (e.g., operations and maintenance expenditures) involve procurement as reported to OASD.

A "typical" procurement is usually thought of as the result of
a random drawing from the population of all procurements. It is in
this sense that the average procurement is often thought of as
typical, even though its value is only $3,517. Table 3 shows that
the size distribution of procurements is skewed, and that the average
value commonly used is a deceptive summary measure. This skewness
is a result of combining two types of purchasing under the heading
"procurement." The first type is the purchasing of routine items.
The second type involves the acquisition of specialized products
which are highly technical, highly risky, very complex or very
costly. The dollar value of specialized in distinction to
routine procurements clearly comprises most of the total volume of
procurement, while the reverse categories dominate the numbers
column in Table 3. These two types of procurement are presently
handled by very different mechanisms. Because of its dollar volume
we shall concentrate on the specialized procurement.

The Cost of the Procurement Activity

The Defense budget provides only an estimate of the cost of
the items being procured. Also of specific interest to us is the
cost of procuring the items. The National Commission on Procurement*
estimated that the procurement work force in DoD totaled 66,000 in
1971. This accords with our own estimate that about 51,000 man-years
per year are allocated to procurement within DoD.** The direct cost
of these man-years was estimated to be $732 million, with overhead
likely to push the total to $1.5 to $2.3 billion.

----

*
Source: *Report of the National Commission on Government Pro-
curement,* Vol I, Appendix E, 1972. The Report itself consists of
four volumes and its reading is highly recommended to any reader
seriously interested in this subject.

**
Carson E. Agnew, "The Magnitude of the Procurement Activity: A
Preliminary Assessment," *ARPANET MANAGEMENT STUDY: New Application
Areas,* R-148, Cabledata Associates, Palo Alto (May 1974), Appendix D.
(This is the first Quarterly Technical Report of the present project.)
Available from NTIS as AD783508.

The True Cost Iceberg

The visible portion of procurement activity is like the tip of a very large iceberg. The true cost of the procurement activity necessarily goes beyond the visible portion of costs in the same way that the true size of an iceberg includes the portion hidden under water. The tip of the cost iceberg is the DoD manpower commitment to the procurement process. Along with this one finds a similar industry expenditure on procurement personnel; since the government is more centralized than its vendors, it is not unreasonable to estimate on the basis of contractor paperwork that industry also spends at least another $700 million on direct costs of procurement. When normal indirect costs are computed, for overhead and secondary manpower support, the figure could almost double. A ballpark estimate, therefore, yields a manpower cost (direct and indirect) in the neighborhood of $2 billion per annum.

We will show in Appendix A that we can save a little of this expenditure directly. But the real savings potential in the cost iceberg lie in the inefficiencies of the procurement process, also considered in Appendix A of this volume.

Aside from the four measurable components of saving considered in Appendix A, amounting to over $1 billion annually, there are other dimensions where savings might occur. Cost and time overruns represent another large penalty which can hopefully be trimmed. Some recent estimates have concluded that as much as one-third of the procurement budget is consumed jointly by inflation and by bad information inputs.

A hidden cost, but one which may be larger than all the above combined, and one that we have not explored quantitatively, is the failure of the system to encourage feedback and learning. The procurement process is so cumbersome and unwieldy that changes and innovations after the contract is signed are discouraged. Changing a contract means dealing with review chains, forms, and sequential approvals. If problems occur during the contract, which is inevitable in highly complex projects utilizing unproven technology, then the burden of proof is on the firm to justify the proposed

21

change. Guilt and recrimination are among the joint products accompanying any major procurement. The "learning curve" is not properly utilized. Valuable experience accrued during the execution of the contract may be buried and forgotten. From a biological point of view, one might call procurement a "slow-learning" system, since it systematically discourages the generation of feedback information. Continuing the analogy, procurement may be said to lack a reflexive steering mechanism; it has poorly developed sensing equipment, and responds slowly to changes in the environment. The true cost of this failure is difficult to estimate, but we suspect that it is significant.

THE LABOR-INTENSIVE NATURE OF PROCUREMENT

The initial rationale for studying the distribution of Defense Department labor costs was that the cost of an administrative function consists of two factors:

$$\text{Total labor cost} = \text{Quantity of labor required for performance} \times \text{Cost per unit of labor required}$$

Automation can be used to reduce the labor input required to perform a given function, but only at some cost for hardware, software and operations. Since current automation technology is characterized by large fixed costs, regardless of the function to be automated, it is best to choose functions involving large numbers of expensive man-hours as the first to be augmented by automation.

The quantitative dimension of this observation can be seen by looking at the distribution of labor cost among DoD employees graded by the Civil Service in relation to the distribution of the numbers of these employees. The employees of the Defense Department employed in procurement are roughly comparable in grade and pay to all the graded DoD personnel. The average direct salary of these employees is $7900, and the median is $11,500. But the distribution of these costs tells an important story.

There are two peaks in this distribution. One of these occurs in grades GS-11 through GS-13, and the other in grades GS-3 through GS-7. Employees in the higher of these two ranges, paid between

$16,000 and $24,000, occupy the middle managerial positions. The lower group, paid between $7000 and $12,000 per year, are lower managerial, clerical and secretarial personnel. The upper managerial ranks begin at about GS-15 with salaries of $29,000 and up. This distribution suggests that middle management positions of the type common in procurement are good candidates for information automation. The "supergrades" GS-16 and above comprise 0.28% of the graded positions and account for only 0.71% of the wage bill. On the other hand, grades GS-11 through GS-13 comprise 27.6% of the personnel and receive 40.2% of the wages. Based on our estimate of the cost of procurement given above, these three grades alone account for $294 million per year in direct salary expense and perhaps $600-$900 million with indirect expenses.

The Procurement Work Force

Some of the characteristics of the procurement work force can be found in the National Commission on Procurement reports.* The Commission's profile of the population shows marked differences between the civilian and military personnel connected with procurement. Some examples of the differences are:

1. Experience. 70% of the military group have less than 10 years' experience and 34% of the military group is in grades GS-13 and above.

2. Age. 59% of the federal government procurement civilian work force is over 46 years of age while about 60% of the military group is under 35 years old.

3. Responsibility. 18% of the civilian group is at GS-13 level and above.

4. Education. The civilian group average was high school plus about three months of college, while 64% of the military group were college graduates with about 25% with graduate or law school degrees.

5. Composition. 92% of the total staff is civilian; 8% military.

These numbers provide useful insights into the characteristics of the users and their probably acceptance of new automated systems.

----

*
Op cit.

The largest component is the civilian component. Here we must
accommodate an age-education group that has in past automation ef-
forts been the most reluctant and difficult to adapt. (The younger
the staffs and the greater the education level, the more comfortable
they tend to be with computer terminals and automated processes.)
Older workers tend to object less after they are shown that they
will be "buffered" from the terminal and there is no loss of job
security. But, some past automation efforts have failed simply
because they were sabotaged* by the older workers who feared the
system. For example, automation of newspaper typesetting has been
held up many years because the older workers were reluctant to
retrain -- even with offers of job security.

These numbers tell us that we must be very careful to design
and implement the system in a manner that is least threatening to
its user constituency.   .

If the goal is as we believe it to be, the more effective use of
existing staffs, then the composition of this work force suggests the
automation system has an additional role in providing computer-aided
instruction to compensate for the high rate of personnel turnover an-
ticipated, as well as offering cross-training to increase job interest.
A policy of not filling some of the positions as they become open dur-
ing the next five years should suffice. But if, as we believe, the
goal should be making more effective use of existing staffs, then the
composition of this work force suggests that the computer also has a
role in computer aided instruction here for the high turnover component
anticipated, plus making the job more interesting for all.

THE GEOGRAPHIC DISTRIBUTION OF PROCUREMENT

We live in a big country, and the geographic distribution of
procurement spending and employment reflects this. Some represen-
tative measures of dispersion are shown in Table 4. Because

----

*
This word sabotage is used precisely in its original meaning,
deriving from the "sabots" (shoes) that the 19th Century French
textile workers threw into mechanized looms to protest possible
loss of their jobs. Automation is not new, neither is resistance
to its adoption.

defense contractors and interacting government agencies are dis-
persed throughout the country, the procurement activity is similarly
distributed. This necessitates travel and communication expenses
which could, for example, be decreased if conferences could be con-
ducted remotely by electronic means; if approvals and comments could
be gathered automatically; if correspondence related to each procure-
ment could be more rapidly generated, handled and centrally filed.
The new computer netting art makes an automated procurement system
that can perform these functions closer to reality than possible in
the past.

TABLE 4

GEOGRAPHIC DISTRIBUTION
OF GRADED CIVILIAN EMPLOYMENT

Region	Percent of total DoD employment in this region[1]	DoD employment as a percent of non-agricultural labor force
New England	4.29	.94
Middle Atlantic	11.31	.80
East North Central	9.16	.62
West North Central	3.99	.72
Southern Atlantic[2]	17.88	1.70
East South Central	5.55	1.35
West South Central	11.39	1.79
Mountain States	6.94	2.39
Pacific Coast	20.63	2.17
District of Columbia	8.78	12.86

[1] Does not add to 100.00 because of overseas employees.

[2] Except District of Columbia.

Sources: U.S. Civil Service Commission, *1972 Annual Report*, (March 1973)
          p. 63

          U.S. Bureau of Census, *Statistical Abstract of the United
          States: 1973*, p. 229

PROCUREMENT IS AN INFORMATION-INTENSIVE ACTIVITY

Procurement requires the processing of large amounts of information by many different groups and individuals. A systems procurement of even moderate size will involve a systems command headquarters and one or more of its local branches, several non-service agencies from the Department of Defense, contractors and sub-contractors, and members of Congress and the public. The information processing function performed by these groups requires the creation, reproduction, distribution, perusal and filing of large numbers of documents. Conferences, telephone calls and briefings are also activities carried out in support of the information processing done by these groups. Indeed, so much of the activity carried out under the heading "procurement" is pure information processing that it seems correct to characterize it as an "information-intensive activity" as well as a labor-intensive one.

New Solutions to the Problem

Until now it has always been necessary to process information manually. Even a year or two ago the state of the art in computer and communications technology was insufficient for automation to be an economic alternative to most of the paperwork load here. But emerging technology, especially the development of national digital communications networks and of minicomputer systems which access large mass memories, begin to make it possible to augment the information processing ability of human beings by automated means. The goal here should not be a one-for-one replacement of highly routine manual procedures. Rather the opportunity exists to provide new features in the emerging systems to make people more productive by unburdening them from having to store, retrieve and transmit routine information and limit involvement to dealing only with exceptions. Office procedures will be revolutionized by the disappearance of paperwork and the increased use of parallel instead of serial procedures. We can seek to cause the markets for goods and services themselves to operate more efficiently, because the information on which decisions are based will be more readily and rapidly accessible

26

and more widely distributed. To be more specific here requires a
few observations from economic theory.

Information Failure and the Non-Market Nature of Procurement

In a "pure" neoclassical market, supply, demand and price
play crucial roles. The producer, facing a known supply function,
decides to raise capital and bring a product to the marketplace.
The product price and characteristics are chosen to maximize the
return to the producer's efforts, and are highly affected by con-
sumer tastes. The producer normally takes action, in the form of
advertising, which is designed to affect consumer preference in
favor of his product. To the extent that this process is success-
ful, consumer preference and the producer's supply possibilities
will be matched by the producer to achieve maximum profits. The
consumer exercises his preference by spending money, and this
currency is the information medium of the market. The market is,
primarily, an information system.

The procurement process works very differently. First, it is
the buyer, not the seller, who takes the initiative to develop a
product. The government agency, through internal means, will recog-
nize that it has a need, and will move to interest suppliers. The
risk capital is usually supplied by the consumer, not by the pro-
ducer -- although in some cases the producer and consumer will share
the risk in some measure. The supplier is discouraged by disallowing
overhead costs for advertising, on the assumption that the consumer
knows what he needs without undue influence. The consumer often
pays for the product before it is completed, and if dissatisfied,
must pay the full cost anyway. Decisions are centralized in the
bureaucracy, and normally there is a monopsony. Price is very often
not the determining feature of the decision, with variables such as
timeliness and quality taking precedence; in some extreme cases
(such as the Polaris missile) price is an almost irrelevant con-
straint. Consumer preference is revealed through a long non-
monetary process, and often the object of procurement is to help
crystallize preference. In short, information is not processed or
distributed in a manner which produces efficiency.

27

Procurement involves a market, but it is not a neoclassical market. The distinction is crucial, since if we assume a neoclassical market, then structural changes designed to change information flows so as to alter incentives and performance would be misapplied and inappropriate. Rather, some of the information functions which operate to make a neoclassical market efficient ought to be adopted in non-neoclassical situations. In particular, the decentralization of decisions and the emphasis on consumer satisfaction can be promoted by changing the information flows which operate in the procurement process.

The Role of Costly Information

The procurement process is information intensive. Its present structure seeks to minimize costs associated with obtaining, storing, processing and disseminating information. For example, because the information required for effective management does not increase in proportion to the dollar value of a contract, a work-saturated management system will tend to favor the issuance of a small number of large contract orders instead of a large number of small ones. And, because the requirements for information increases significantly for contracts that go out to open bids, there is a tendency to use a variety of non-competitive procurement methods instead of competitive ones.

This tendency towards large contracts awarded on a non-competitive basis represents rational but suboptimal behavior on the part of procurement management. From their point of view, they seek to be as efficient as possible in their operation, subject to the constraints of existing procurement law and regulation.

There are a number of good national policy reasons that suggest that a larger number of smaller contracts are preferable to a smaller number of large contracts. An increased number of smaller contracts reduces the variance of a company's business backlog. More importantly, this mode increases competition by decreasing the minimum size a firm must have to handle

a given contract. A non-competitive award is another way of saying that the contractor, for any one of seventeen allowable reasons,[*] has a monopoly on at least one sector of the government's business. Since 65% of all procurement dollars are spent in this non-competitive sector, this is not an unusual condition. If economic theory holds here as it does elsewhere in the economy, the price to the government must contain an invisible loss component. The magnitude of this difference has been estimated[**] to be as great as 50%. It should be emphasized that no one steals this monopoly state profit. Every penny is accounted for to the government. But, the amount of the fee is directly proportional to the total size of the contract. Thus, there is a little less disincentive to hiring of armies of partially competent people in preference to a smaller number of persons better matched to the tasks. Without competition there is really no way of knowing whether a better or cheaper alternative exists. Again, this is not saying that defense contractors are making excessive total profits. This is a low return on investment business. Rather,

----

[*]Based on FY72 data, these are:

1.	National emergency (sub-total)		5.2
	A. Labor surplus area & indistry set-aside	0.6	
	B. Small business set-asides	4.5	
	C. Balance of payments program	0.1	
	D. Combined small business/labor surplus area set-asides		
2.	Public exigency		5.0
3.	Purchases not more than $2,500		4.2
4.	Personal or professional services		0.2
5.	Services of educational institutions		1.3
6.	Purchases outside U.S.		4.5
7.	Medicines or medical supplies		0.4

[**]"The Acquisition of Weapons Systems," *Hearings before the Subcommittee on Priorities and Economy in Government, of the Joint Economic Committee, Congress of the United States*, Part 7, Washington, D.C.: Superintendent of Documents, November 1973, pp. 2593-2594.

the loss is merely one in efficiency that the government must always pay in the end.

We believe that the observed absence of competition in procurement is more realistically a consequence of the way in which procurement is managed, rather than vice-versa. However, once the lack of potential competitors is noted, this observation reinforces the tendency to manage a few large procurements. We believe that the driving force behind this process is not the lack of bidders but the costliness of information under the current procurement process. A major component of the savings that are considered in the Cost-Benefit Analysis (Appendix A), is based upon new information automation capabilities for procurement officers to handle the information which is collected. These features of an automated system should allow a reduction in the size of a typical procurement, with a consequent lowering of entry barriers and an increase in competition. We show in Appendix A that this increased competition can provide substantial tangible savings to the government.

8.	Supplies purchased for authorized resale	0.9
9.	Perishable or non-perishable subsistence	3.4
10.	Impractical to secure competition by formal advertising	24.3
11.	Experimental, developmental, test or research	12.8
12.	Classified purchases	0.3
13.	Technical equipment requiring standardization and interchangeability of parts	0.4
14.	Technical or specialized supplies requiring substantial initial investment or extended period of preparation for manufacture	18.7
15.	Negotiation after advertising	0.5
16.	Purchases to keep facilities available in the interest of national defense or industrial mobilization	5.7
17.	Otherwise authorized by law	2.1

Note: The percentages add up to only 89.9% because the other 10.1% were formally advertised.

TIMING FOR POSSIBLE CHANGE

The procurement process has been singled out for institutional updating through the formation of the National Commission on Procurement and, more recently, through the creation of an Office of Federal Procurement within the Office of Management and Budget. The Report of the Commission has been a valuable tool to us during our work. But the Commission's Report is also interesting for what it does not say. It does not, in particular, address the automation issue. We believe that many of the Commission Report's objectives could be much better met provided such capabilities existed. The absence of inclusion of demands for information automation may be simply because there was no realization of what could be done. Rather, the Report's authors limited themselves to viewing the future without an appreciation for the full impact of the new technology.

Congressional concern with the issues of procurement reform is high. This may be a good occasion to raise the subject of what technology can do here that legislation alone cannot.

2. SYSTEM DEVELOPMENT

This chapter addresses the issue of desirable characteristics of the procurement automation system of the 1980s. This requires a consideration of the functions which can be performed by automation and an extrapolation of the capabilities of software and hardware technologies through two generations of computing machinery, as well as a projection of the future environment of a procurement automation system.

Starting with the concept that major economic and other benefits occur with the contemplated form of information processing automation, several questions defining the subject are appropriate:

1. What would the system configuration look like, if built by the mid 1980s?

2. What would the system do for its users?

3. What software will be needed to support these needs?

4. What hardware configuration will be needed?

5. What environment will this system face then?

CONFIGURATION

For sake of discussion, we describe a hypothetical system below to serve the entire DoD procurement activity. This is useful in estimating costs and benefits as well as in specification of desired system properties.

Figure 2 shows a sketch of the potential users connected to their communications interface.

Figure 3 shows a sketch of the user communications network. Shown is a terrestrial packet network, but packet radio would probably be even better here. Connected to this network is a set of eleven computer centers.
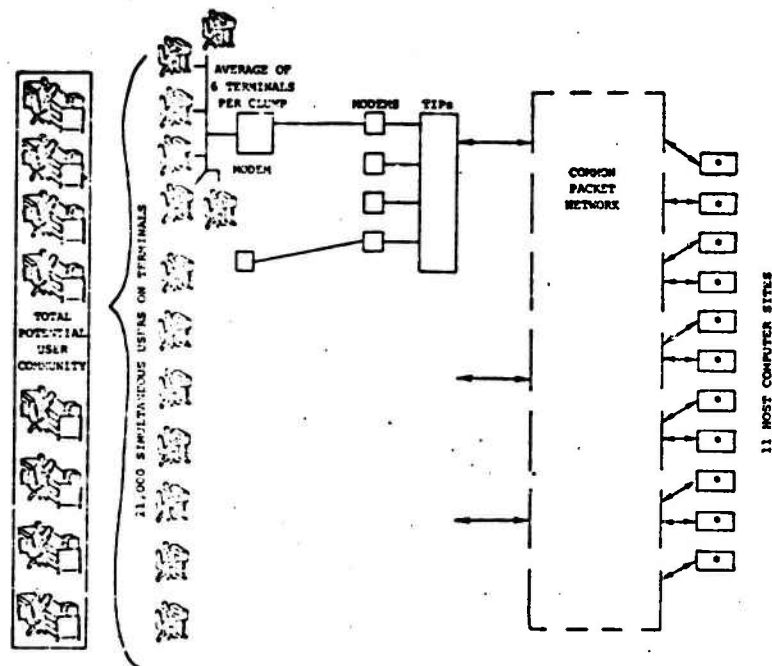
Figure 2. 11,000 users addressing 11 hosts.
-----
*See Figure 5.
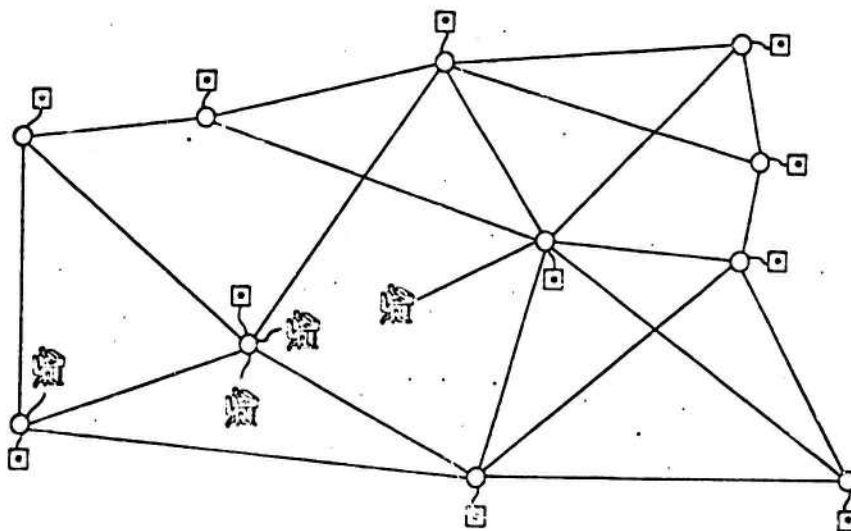
Figure 3. Packet network connecting eleven central computer sites.
-----
*See Figure 5.

Figure 4 shows a sketch of a test experiment that could be conducted in which only a few dozen people could be used to simulate the performance of a "test-bed" system.

A few dozen
   users
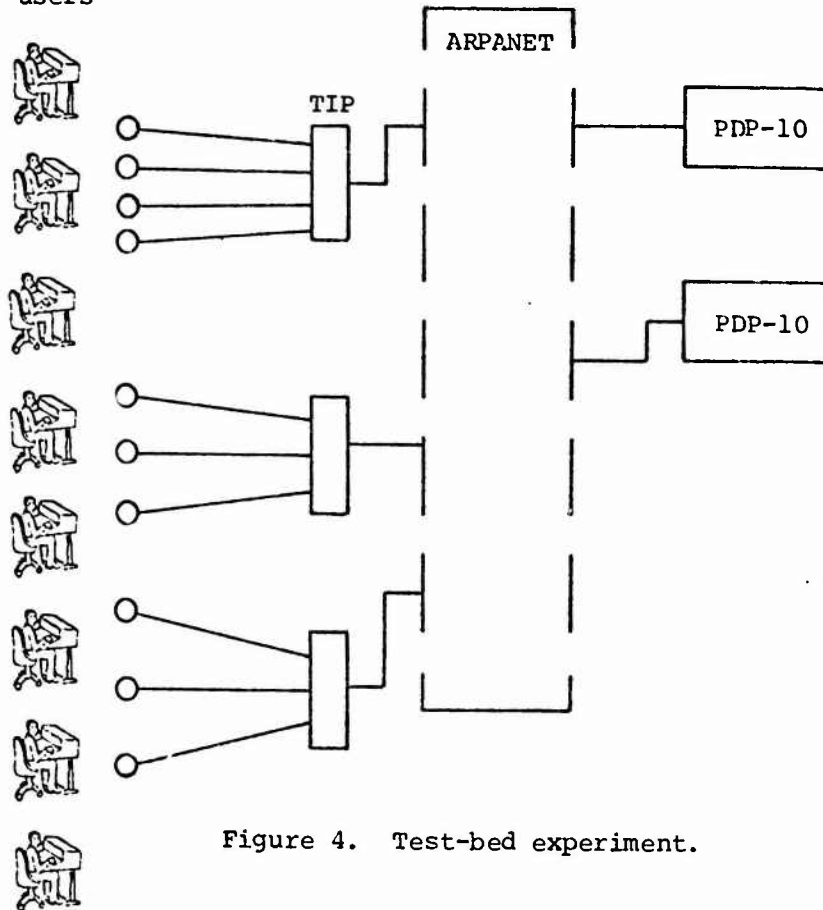
Figure 4.   Test-bed experiment.

SERVICES

    Table 5 describes the applications as seen by the user,
the procurement functional needs performed in each application,
and the specialized hardware or software required for its per-
formance. This table, then, provides a brief description typical
of the type of services we would envision in the late 1980s.[*]

----

[*] Many of the software features and the procurement functions
which they support are described in more detail in Cabledata
Associates' First and Second Quarterly Technical Reports, both
entitled *ARPANET MANAGEMENT STUDY: New Application Areas,*
(available from NTIS: AD 783508 and AD 787039, respectively),
5 May 1974 and 5 August 1974.

TABLE 5

AUTOMATED APPLICATIONS SUPPORTED IN A MATURE PROCUREMENT AUTOMATION SYSTEM

Application Name	Brief Application Description	Procurement Functions Supported	Special Hardware or Software Required
Procurement reference system	Maintains for retrieval a large ($>10^{10}$ char) data base of procurement regulations, specifications and standards, indexed by content, source, cross reference, etc.	• Preparations of WS/RFP/IFB and contracts • Contract administration and enforcement • Common reference for DoD and contractors	General purpose information retrieval system, limited text editor, OCR processor
On-line office	Provides text creation and editing facilities, plus file handling and storage, for procurement documents. Includes access control and tracing for correct routing, accountability and security.	• Preparation of WS/RFP/IFB, proposals and contracts • Internal document preparation	Full text editor, support for "smart" terminal, on-line file handler, access trace and security modules.
Procurement data retrieval system. Typical files include:	Supports retrieval (by specified indexes or by content) of volatile, restricted or limited-interest information.		General purpose information retrieval system
BROKER	Information on cost and performance of high technology items, intended for use in place of negotiated procurements.	• Advertised and negotiated bids • Completion of large systems contracts	Network protocols, access checking, forms processing
Contractors' file	Information on past performance and current activity of DoD contractors.	• Source evaluation and selection • Preparation of WS	Security checking
Procurement status system	Data on status of all DoD systems procurements, including names of cognizant individuals and organizations and planned routing of procurement documents.	• Procurement scheduling (with DoD and among contractors) • Manpower allocation	Data capture from access trace facility
On-line conference and review system	Permits synchronous conferences or asynchronous (e.g. parallel) review of text on-line. Records comments and access history.	• Source evaluation and selection • Pre- and post-award conferences • Internal meetings (substitute for travel)	FORUM-like conference system, network protocols
Electronic message service	Works in conjunction with on-line office to eliminate drafting and transmission of hard copy documents.	• Internal procurement planning • Contract administration	Message system, cryptographic software/hardware, text editor
Forms processing	Automates the entry of data into required and optional forms.	• Bid or proposal preparation	Forms capture software, "smart" terminal
Logistics management systems, such as:	Supports a variety of procurement functions relating to logistics items.	• Advertised procurements • Logistics management	General purpose data management system, including distributed data base support
Base inventory control	Monitors requirements and utilization of items at base level, summarizing by command.		
Automated ordering and billing	Mechanizes paperwork for entire logistics procurement process for routine items.		
Accounting support systems	Provides accounting and management reporting for logistics and systems procurements.	• Procurement management • Contract administration	A variety of separate systems sharing some of their data bases

The mature system which we envision would augment the procurement process in several ways; some familiar, such as the inventory control functions performed by logistics procurement systems, and some new. The new functions include:

 o <u>Information retrieval</u> -- such applications as the procurement reference system, the contractors' file and the procurement status system all attempt to make the

task of remembering details a problem for machines and not for people. By using a system which can rapidly retrieve information by its content or by some index, procurement personnel will be able to focus their attention on the larger problems of systems procurement. This division of labor is likely to be highly productive, because people are good at solving and working with fuzzy problems, while computers can remember facts perfectly.

o <u>On-line communications</u> -- is supported by applications such as the on-line office package and the conference and review system. Taken together, these systems make it possible to conduct much of the business of procurement -- such as drafting reports and correspondence, reviewing other documents, and coordinating a geographically distributed activity -- without repeated retyping of documents, and with a substantial reduction in travel.

o <u>Efficient and economic procurement of a wide variety of items</u> -- can be accomplished through the logistics and accounting routines (many already in place) as well as through new systems such as the BROKER system. By maintaining information about DoD needs and about product prices and characteristics, considerable savings in time and money should be possible, since all alternative suppliers and all demands can be considered at once.

These areas and the applications which support them may sound rather futuristic to the reader of this report -- like an ode to the MIS concept, written several years too late. But it should be emphasized that the applications listed in Table 5 are part of the current state of the art and exist in some preliminary or operational form. For instance, the reference system and other information retrieval tasks such as BROKER could be supported (at least conceptually) by one of the general purpose retrieval systems such as the Stanford University SPIRES system or Lehigh University's LEADE   r by the Avionics Central System at Wright-Patters... \i.   rce Base. The ARPANET exists and works quite well and conferencing experiments such as FORUM exist. Message service exists via SNDMSG and LINK. There are a number of on-line text editor/terminal systems, such as XED, NLS, or TECO, but in all cases the human factors are not fully appropriate to the task. The BANANARD program is very useful here and comes very close to the sort of human factor input/output that will be needed for a system for non-experts.

36

SOFTWARE MODULES FOR THE PROCUREMENT AUTOMATION SYSTEM

Table 6 shows the software modules which would be required for
the complete implementation of a mature system supporting the first
six applications shown in Table 5. Those modules listed under the
Operating System could be provided by an existing system for an
experimental test, or by new hardware or software for a maximum ef-
fectiveness tailored specifically for the function. The list
presented here is not intended to be definitive.

The required modules include language compilers and inter-
preters to be used in writing the other code used by the procure-
ment automation system (2.1). In line with the recommendations on
security and privacy, the compilers would be inaccessible to system
users. (No user code would be executed at most sites.) The file
handling system (2.2) is required to manipulate user files, and
includes sorting and report generation packages. The file handler
would also have to interface with the system security modules in
order to verify the ability of a user to access or modify a file.

The information retrieval system (2.3) and the text editor
system (2.4) form the core of many procurement automation system
applications. The submodules listed in these two sections would
not all have to be written together. For instance, the smart
terminal support and composition commands of the text editor could
be included after the basic file change commands were implemented.

The forms processor module (2.5), the graphics processing
module (2.6) and the FORUM facilities (2.7) each support a separate
application within the procurement automation system. Two sub-
modules of the graphics processor support the input of graphics,
coding and storage, while the other supports the retrieval or
generation of graphics for on-line use. The FORUM features can be
similarly decomposed into a synchronous conferencing module and an
asynchronous review and comment module.

Finally, the access trace processor (2.8) and several miscel-
laneous routines (2.9) are used for a variety of purposes. Access
trails can be generated with respect to users or files or programs.
Normally these trails are dumped off-line and a report generator

TABLE 6

SOFTWARE MODULES FOR THE PAS

1.0 Operating System

    1.1 Scheduler
    1.2 Resource allocation
    1.3 Storage management

        1.3.1 I/O drivers
        1.3.2 Audit trail generator

    1.4 User terminal control

        1.4.1 Communications terminal control
        1.4.2 Network Control

    1.5 Diagnostic and recovery package

        1.5.1 System reconfiguration
        1.5.2 File recovery
        1.5.3 System performance monitoring

    1.6 Security

        1.6.1 User validation/verification file
        1.6.2 Encryption/decryption
        1.6.3 Storage protection

    1.7 Accounting

    1.8 Command language processor

2.0 System Software Modules

    2.1 Language compilers and interpreters

    2.2 Data management (file handler command language)

        2.2.1 Tape/disk file creation, deletion, update
        2.2.2 Sorts
        2.2.3 Report generators

    2.3 Information retrieval system

        2.3.1 File definition
        2.3.2 File maintenance
        2.3.3 File search (command language processor)

    2.4 Text editor(s)

        2.4.1 Basic file change commands
        2.4.2 Support for "smart" terminal
        2.4.3 Composition (typesetting) commands

    2.5 Forms processor

    2.6 Graphics processing

    2.6.1 Input processing
        2.6.2 Retrieval/generation software

    2.7 FORUM facilities

        2.7.1 Synchronous conferencing
        2.7.2 Asynchronous (review and comment)

    2.8 Access trace processor

        2.8.1 Report generator
        2.8.2 Data capture
        2.8.3 Audit trail

    2.9 Miscellaneous

        2.9.1 TTYTST
        2.9.2 HELP, EXPLAIN
        2.9.3 LINK
        2.9.4 SNDMSG and READMAIL
        2.9.5 KWIC index generator

program is used to reconstruct them in a coherent fashion. The audit trail facility, however, should permit tagging particular users or transactions so that they will print out in real time at a particular secure terminal. The miscellaneous submodules are intended to give a non-inclusive list of some features which the system would probably have. Abbreviations are based on TENEX and other contemporary time-sharing system commands.

A HARDWARE CONFIGURATION

An overall system diagram has been shown in Figure 3. A conceptual hardware block design to support automated DoD procurement activity in each of the 11 sites is shown in Figure 5. The design proposed is not intended to be a definitive statement; its intent is solely to suggest the mature system can be built in the 1975-1980 time frame at modest cost using only mature hardware technologies.

Figure 5. Host computer system.

39

The hardware system consists of two major parts:

1. A number, on the order of 11, of host computer centers, each specialized for efficient handling of a particular sector of procurement data processing requirements. Growth would be evolutionary after the first two or three.

2. A packet switching network connecting these hosts. This network could be a self-contained broadcast satellite system or an overlay user network on a commercial packet switching network using telephone lines.

The host computer's central processor in Figure 5 is a multiprocessor using seven independent minicomputers as central processing units. Serving the processors are memories organized into a four or five level hierarchy ranging from solid state random access main memory to an archival bulk memory (located at one or two of the hosts) such as Ampex's TBM or a full complement of 32 moving head disk drives (6400 MB). The architecture proposed is somewhat unusual -- the use of a group of minicomputers in a multiprocessing configuration to control a very large complement of peripheral storage. We chose this configuration primarily because:

1. The desired performance at the desired high reliability level could not be met with the more usual system configurations.

2. The system configuration lends itself to privacy and security maintenance techniques.

3. The low cost and very powerful processing capabilities of some of the new larger minicomputers provide a system of total overall lower cost than other alternatives considered.

The host computer system is structured so that no single hardware subsystem failure can seriously degrade system operation -- with the inevitable single exception. That single subsystem that remains critical to host operation is the main memory. However, the main memory can be partitioned so that no single failure would make more than 25% of the memory unavailable. Most failures would not affect more than 6.25% of the first level memory's capacity. At this time we believe that the main memory can be built with an MTBF (mean time between failures -- unanticipated errors) in excess of 1500 hours. The MTTR (mean time to repair) is 30 minutes for 90%

40

of the failures encountered. Peripheral subsystems are divided into
two sections, so loss of one section will not affect operation of the
other. Peripheral controllers can be distributed across the memory
ports so that failure of any one port cannot affect more than half of
the rotating storage media peripherals. Each peripheral con-
troller accesses two control ports and is serviced by one of two CPUs
as dynamically determined by the CPU assigned the diagnostic function
role. In most cases a malfunctioning CPU's functions can be taken
over by another CPU upon direction by the diagnostic CPU without
necessity for human intervention. The CPUs would all be plug com-
patible allowing a spare CPU to be recabled to replace a malfunctioning
CPU in a matter of minutes.

The diagnostic CPU (or pair of diagnostic CPUs) would be the only
CPU(s) in the system dedicated to a unique function. The CPUs assigned
to resource allocation, file management and communication have specific
tasks by virtue of their I/O bus connections to particular controllers,
but can share in the general computational load as directed by the
operating system software. If more computational capacity is needed,
additional CPUs can be connected to spare memory ports 15 and 16 shown
in Figure 5.

The cost effectiveness advantage of using CPUs of modern design
over conventional mainframes is significant. A comparison between
three CPUs (the IBM 370/145, the DEC PDP-10 and the Interdata 7/32)
was reported in an earlier report.* Gibson mix** calculations were
made for each of the three configurations described and a somewhat
arbitrarily defined figure of merit was calculated for each of the
machines. There was a factor of 50 between the price-performance
ratios of the best and worst CPUs. Table 7 shows the final hardware
cost estimate derived from this study.

----

*
  ARPANET MANAGEMENT STUDY: New Application Areas, R-148, Cabledata
Associates, Palo Alto (May 1974), Appendix I. (This is the first
Quarterly Technical Report of the present project.) Available from
NTIS as AD 783508.

**
  C.G. Bell and A. Newell, *Computer Structures: Readings and
Examples* (New York: McGraw-Hill Book Company, 1971) pp. 49-50.

TABLE 7

COST ESTIMATE, EACH CENTRAL COMPUTER INSTALLATION

1 Memory unit modular 512K 16/32 bit words - Systems Concepts Corp. (same type as to be used in Illiac IV memory)	$1,000,000
4 Disks, swapping media DDC #9113 @ $54,000	216,000
16 @ 7330 Mass disk (Itel) 50 ms maximum, 20 ms average 100 Megabytes @ $13,000	241,000
6 or 8 @ $30,000 Processors	250,000
Archival Store, such as Ampex terabit w/14 transports + channels & cabling 6.44 x 10^{11} bits	720,000
Cabling, cases, consoles, flooring, etc.	300,000
1000 Modems/Concentrators	250,000
	2,977,000

Table A-5 of Appendix A shows the cost estimate for the total system of which the hardware portion described is only a part.

ENVIRONMENT

We cannot realistically talk about any future system without an appreciation of the environment it must serve, therefore let us consider the environment for this system in the 1980s. To do so we shall first assume that the procurement process will remain basically unchanged in legal and administrative structure during the next decade.

Secondly, we assume that there will be no radical changes in the mix of Defense purchases. But, we also postulate some changes in the environment. In particular, and most importantly, will be an anticipated tighter overall constraint on the level of Defense expenditures. Our reasons for this hypothesis are in order. Let us consider the environment of the last few decades. Here the national concern about defense against a foreign aggressor was so overwhelming that the Department of Defense was able to request, and Congress to a generally high degree concur in providing a significant percentage of federal spending, constituting a relatively high percentage of the National GNP annually. For the last 30 years Defense accounted for the overwhelming portion of governmental expenditure.

Figure 6 shows some clear changes in these trends.
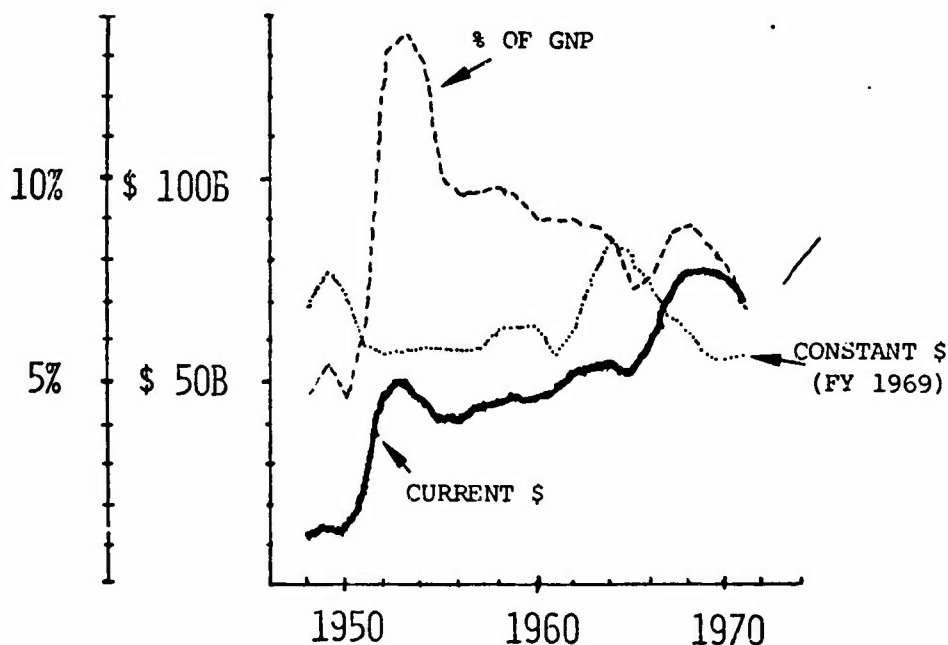
Figure 6. U.S. defense spending.

Sources: (1) Neil H. Jacoby, *Corporate Power and Social Responsibility*, (Macmillan, 1973) pp. 225-245.

(2) *The Economics of Defense Spending: A Look at the Realities*, Department of Defense (Comptroller), SupDocs #0800-00176, 1972.

For example, consider the trend of national defense expenditures in
current dollars. It is a clearly rising curve. But, if we consider
DoD expenditures in deflated (constant FY1969) dollars, the picture
is different; this curve is a straight line showing essentially level
spending since 1952. And, lastly and most importantly, if we con-
sider the Defense budget as a percentage of GNP, the best measure
of national priorities, we see a rapidly declining curve.

These trends suggest that funds for defense will be increasingly
"tight." If we believe that a nation's priorities are expressed in
the nation's budget, the signal to the future defense planner is
clear. Less money as percentage of GNP; probably even less money in
terms of constant dollars.

The public consensus for unquestioned support of Defense expen-
ditures has disappeared, and may not appear again unless the nation
faces a unifying catastrophic challenge. Therefore, the burden of
efficiency and cost effectiveness will be increasingly felt by DoD
management in the face of public scrutiny and criticism.

During the last seven years public trust (as measured in a
number of opinion polls) in all large institutions in the U.S., par-
ticularly the Department of Defense, has declined dramatically.
Although detailed opinion polls do not exist we believe that a cor-
responding level of trust in the honesty and wisdom of those involved
in day-to-day procurements may have also diminished. This, in
absolute terms, is unfortunate. But, if those who attack defense
expenditures on economic grounds were also to fortify their position
by questioning the present procurement system, which seems to require
that over half of all procurement dollars be spent in a non-competitive
fashion in order to operate without overload, it could pose a potential
crisis. Thus, the new system capability sought in this report for
economic and defense needs may be needed for a completely different
set of reasons -- public distrust of the process. We may never again
see an environment where the defense procurement process is the sole
concern of a small group of trusted leaders whose decisions are
rarely to be questioned. Extrapolation of past trends takes us to a
domain where openness and accountability may be essential in designs
for DoD procurement automation in the future.

3. NEXT STEPS

Carrying the existing procurement automation system from the
present to the future calls for planning. Effective planning calls
for a knowledge of what exists and an assessment of the availability
and importance of any pieces of the final system which do not exist.
This chapter addresses these issues in summary form. In review,
many of the components required for future procurement automation
already exist. A few components, including tangible and intangible
items, do not exist and must be developed.

WHAT EXISTS?

Appendix C contains the results of a survey of what exists now
and in the near term in DoD procurement automation efforts. Existing
systems are summarized in Table C-1. As will be seen from Appendix C,
routine small scale procurement support activities have enjoyed the
highest degree of automation. This is true at the *base* level (e.g.,
CIAPS), as well as at the *branch* level (e.g., ALS, ALPHA).* In
addition, the Defense Supply Agency's support mission (e.g., SAMMS)
has fostered a broadening of interface standards both between branches
and across to contractors. The activity is well known, and both the
organizational structures and software appear to be mature; that is,
the automated procurement functions are carrying an increasingly
heavier operational load. Also, the contract administration facet of
logistic procurement (e.g., MOCAS) enjoys an important operational
role.

----

*
A description of these systems is contained in Appendix C,
SURVEY OF PROCUREMENT AUTOMATION SYSTEMS IN PRESENT USE.

These systems are not in themselves or in concept completely handling the job. However, the most important parts have been accomplished: (a) the *thinking* has had a chance to be tempered by experience, (b) the *design* facilities, the programming shops (e.g., the Design Center at Gunnard AFB) are in full operation with an experienced staff, (c) the *implementation* and retrofit headaches have been faced and solved, and (d) the *evaluation* and *re-design* procedures are in evidence. In organizational manpower and technological aspects, the capability appears to exist upon which to expand and grow. Necessary resources appear to be generally available, albeit unmobilized.

However, the picture is less developed for the domain of large scale specialized, or systems, procurement. As was previously mentioned, such large systems procurements are qualitatively different from routine item procurements. The former are almost by definition unique. DoD has not yet developed "mature" management concepts for automating the systems procurement process. But, some approaches (AMIS, SAFEGUARD, MIS) *have* explored and designed key segments of the process.

A leap of faith might suggest that the cumulative experience of the last 15 years will be sufficient to render workable, practical designs for the systems procurement problem. In favor of this view is the observation that systems such as AMIS were not developed in a vacuum. AMIS is sensitive to its sister, ALS, and to the MILSCAP directive itself. It is therefore guided and constrained by existing systems while it pushes forward the state of the art.

Another key element that already exists is the DoD "information utility" (FLITE and Avionics Central). The procurement process as detailed earlier* relies heavily on such text as ASPRs, the U.S. Code, the Comptroller General's Report, and the Federal Reporter. It is

----

*
ARPANET MANAGEMENT STUDY: New Application Areas, R-148, Cabledata Associates, Palo Alto (May 1974), Appendix E. This is the first Quarterly Technical Report of the present project.) Available from NTIS as AD 783508.

gratifying to discover that some of this material resides in machine readable form, accessible by advanced storage and retrieval systems. (In fact, we have encountered numerous cases of complete duplication of databases and their maintenance.) Examples of advanced systems such as FLITE's extensive library (120 disk packs, soon to double) and Avionics Central's software package suggest that many formidable tools are already in place upon which to start building the next generation procurement automation system information utility.

Lastly, and most importantly, OSD has shown clear and consistent interest in fostering the development of procurement automation and managerial streamlining in general. The MILSCAP directive is OSD's catalyst, and although the MILSCAP concept has been obliged to undergo several overhauls, its integrating effects are in evidence in every system that we surveyed.

WHAT IS MISSING?

After our survey of current automation efforts, we found that many of the necessary capabilities for an integrated procurement automation system exist, at least in conceptual form, but there are some clear gaps that will need attention:

1. Comprehensive external *standards*.

2. A low cost, widespread effective *computer communications network* capability such as the ARPANET for operational use plus a computer resource snaring capability.

3. An overall *resource sharing* system design.

4. *Architecture* tailored for large populations of non-computer-oriented users.

5. *Research needed* on some critical areas.

Standards

The *external standards* problem needs to be addressed both generally and in specific. That is, interface standards between contractors and the internal branch MIS must be established. This issue can be considered in two stages:

1. Defense procurement consists of two sets of inter-actions, those solely within government and those

between government and with contractors. To obtain
the degree of automation being sought it will be neces-
sary to extend the domain of this automation to include
inputs and outputs from potential contractors.

As a matter of public policy, there is a limit both
to the degree and the speed with which private industry
practices can be modified to fit the clerical processing
needs of government. A long lead time would be helpful
here in permitting business (especially those for whom
defense business is a secondary market) to conform to
MILSCAP-type standards and procedures in their contract-
or pre-contract-related interactions.

2. A different aspect of this issue occurs in the area
of large systems procurements, which involve corporate
management information systems (MIS). The government's
procurement problems are reflected microcosmically in
every large corporation. Compared to the DoD's $50
billion procurement budget, a large defense contractor's
procurement efforts may seem miniscule. However, since
there is a 50% flow out of defense funds in subcontracts,
it seems rational, and possibly inevitable, that some
time in the future an interface can be achieved between
government and private MIS, especially for those activi-
ties which involve large continual flows of information.

The actual list of standards, protocols and procedures
that will have to be considered are beyond the scope of
this study. But, it is not too early to start work if
these standards are not to prove to be the pacing element
in development. The cost of undoing bad standards is
probably exceeded only by a lack of standards.

Computer Communications Network

While the ARPANET exists and is a proven concept, there is an
attitude by the designers of today's procurement automation systems
that no suitable network exists today which makes it easy to inter-
connect widely different systems together. While AUTODIN has been
in service for many years providing digital communications for
computer systems, it was never designed for the characteristics
important to accommodate the full flexibility, fast response time,
low cost and channel capacity commensurate with the loads that
massive computer netting implies. There is a clear need for new
computer communications plant capacity more appropriate to the
degree of computer netting desirable and necessary. More specifi-
cally, the procurement activity is necessarily one that is highly
distributed geographically. The DoD systems mentioned previously

48

encompass dozens of sites with end users scattered over hundreds of separate facilities. Several projects are said to have experienced severe constraint in their planning and/or operations due to an absence of adequate cost effective communication links. An effective DoD-wide procurement system will place a heavy requirement on communication facilities and it is unlikely that a patchwork or ad hoc approach will prove satisfactory to DoD for several reasons including system reliability, response time and costs.

The absence of a viable communications network *in being* for such interconnection today dampens both the designer's and user's propensity to think in terms of a DoD-wide heavily netted system. Without this infrastructure the branches correctly feel that inter-system integration is a far off dream, not an imminent reality. An affirmative OSD commitment to the creation of adequate communications facilities here will be needed.

Resource Sharing

The *computer resource sharing* issue also needs to be addressed. Dozens of large computer installations are being utilized in today's procurement automation. Each center also supports large databases. A rough calculation yields several *hundred* disk packs of active data, backed by several *thousand* archival tapes. New computer resources are being continually purchased, despite increasingly severe budgetary constraints, and we already see a duplication of databases occuring.

The ARPANET experiment serves as one example of what we *do* know about distributed, resource sharing computer networks. A test demonstration and a very large workable system are not the same thing.

System Architecture

The *overall system architecture* is a new subject here. There are two levels of system architecture, the macro level and the micro level. First, at the macro level we see the past approach of the patching together of individually designed subsystems a less effective technique in the future. The benefits of bottom-up system

49

design diminish rapidly as the overall system expands. Even at this stage of procurement automation there exist several unfortunate areas of incompatibility. Conceptually, OSD has confronted the problem via repeated commitment to MILSCAP. Operationally, a design gap has emerged. The procurement automation system as described in this report represents one attempt to fill the design gap.

At the micro level there is a lot of work to be done on resource shared system design -- particularly for systems composed of a multiplicity of minicomputers connected to serve a multiprocessing environment. As this subject has been discussed earlier in this study, it will not be considered in detail at this time.

Research Needed

ARPA/IPTO's charter is DoD-wide research. Of most relevance to this charter is the following discussion of areas that will require additional research before this system's feasibility can be regarded with confidence.

In the past the Department of Defense could afford to proceed with large systems to be built before workable technology existed. This may have been justified in an era where defense was not constrained by lack of dollars. Today, the political realities of fiscal frugality will make it unwise to proceed with a large system design until the fuzzy areas are defined and proven to be within near reach. Thus, the next steps may not be able to come from the operating agencies until the needed foundation research is first performed by others.

The research needed is really a matter of degree. In the following we delineate a number of subject areas where research would be helpful, but it would still be possible to build parts of the system without all the research listed successfully performed.

ARPA/IPTO is already actively engaged in research in almost all of the following areas in its present and tentatively scheduled Program Areas. What may be most helpful here is a coupling of the research being performed to also address the specific needs and requirements of the procurement automation described in this report.

1. *Graphics*. A procurement automation system capable of handling the bulk of DoD procurement activity must deal with some graphic material. Computer-based graphics in the form of digitally encoded representations of graphic entities present a difficult and expensive problem. It takes a great many bits per image to even approach the performance of paper-and-pencil engineering drawing technology. The information needed to approach the capabilities of half-tone printing of photographic technologies is very large indeed, even with sophisticated image compression techniques.

Techniques such as computer retrieval microforms or videodisk technology suffer from the defect that substantial portions of the hardware cannot be shared. Other systems require high bandwidth communications lines and all require that the graphics storage and/or display unit be separate from the computer which stores or displays the text. This inability to multiplex users on the same hardware raises the cost of graphics storage and transmission required to support adequate service.

Digital encoding techniques are as yet very expensive because they require a large amount of computer resources to drive the displays.

2. *OCR technology*. A bottleneck in creation of large files of text is the transfer of the text from printed documents to a machine readable form. Keystroking methods are expensive. Optical character reading (OCR) technology holds some promise as an economical method of machine-encoding printed documents. OCR equipments work very well where only a single tightly controlled type font must be handled. However, when we consider the state of the art of OCR where an open-ended number of fonts must be considered we find that all systems we considered are either unable to read printed text or can read the text at an error rate (resulting from misrecognition of characters) which is unacceptably high. (One observed error rate was six percent; an acceptable rate would be less than 10^{-4}.) However, many of the errors resulted from the machine's inability to separate such common digraphs as 'th' and 'fi' into two letters. We wonder if simple modifications of the basic technology may be all that is required to achieve a significant improvement in the error rate.

3. *Intelligent terminals*. The potential user population for the procurement automation system will consist of relatively naive people (in the sense of inexperience and impatience with typical computer user interfaces). The intelligent terminals research can assist here in several ways:

    a. Sophisticated text editing facilities like NLS can be made more accessible through preprocessing of commands at the user's terminal.

b. Support of large user populations becomes more
feasible if the demand for CPU cycles at the server
can be reduced by intelligent terminal processing.
The NSW (National Software Works) project might
apply here.

c. Since much of the procurement activity revolves
around standard forms, an intelligent terminal
could do much to reduce the amount of "boilerplate"
information the users must enter. Furthermore, on-
line help in filling out these forms could reduce the
need for reprocessing of incorrectly filled out
forms.

4. *Secure systems*. The security requirements of a procure-
ment automation system could range from protection of
military and AEC classified information to protection of
vendor proprietary data contained in proposals or technical
data packages.

In a related area, the validation of users (identifica-
tion and verification of access capability) will be essen-
tial if proposal and contract approvals are to be done on-
line. This problem is equivalent to the verification of
SNDMSG sources to prevent messages from being distributed
over a fraudulent signature.

5. *Interoperability with existing systems*. Users of the
procurement automation system should be able to access
existing services such as Avionics Central at Wright-
Patterson AFB (on-line ASPRs), DDC, IAC, and DSA
procurement automation facilities.

In addition, the close connection between logistics
and procurement, especially in a military emergency,
makes it desirable to interface the procurement automa-
tion system in some way to existing and planned Command,
Control and Communication systems. It is not clear how
such interoperability can best be achieved.

6. *Teleconferencing*. Existing voice and computer-
mediated teleconferencing systems are artificial and
weak, and do not eliminate the need for personal meetings.
By extending the capabilities of the procurement automa-
tion system to multimedia including high resolution, on-
line graphics, secure facsimile, digital voice (secure
and unsecure), many of the problems related to a given
procurement might be ironed out without the need for
travel.

7. *Advanced memory technology*. Any procurement automation
system which supports on-line preparation and retrieval of
RFPs, RFQs, proposals, ASPRs, TDPs (Technical Data Packages),
etc., must include very large memory capacity for storage
and retrieval.

Furthermore, the potentially very large user population
inside and outside DoD will require large scale timesharing

systems which will in turn require large shared memories
to realize fast response in a virtual memory environment.

Advanced System Design

We have described a number of research items that will be highly
desirable in moving towards the goal of building a new procurement
automation system. Simultaneous with such research it will be neces-
sary to start those next steps of preliminary design needed to define
the system in detail. These would include:

1. Review the paper flow, record keeping and reporting
activities of the current procurement system (in DSA and
each of the armed services). Catalog the tasks of each
level of the procurement hierarchy that can be helped
most by access to new generation information processing
capabilities.

2. Determine the geographic extent of the system, the
number of DoD procurement offices and number of contrac-
tors (and subcontractors) involved.

3. Catalog existing procurement related information
activities.

4. Prepare a detailed system design and implementation
plan.

NEXT STAGE RESEARCH REQUIRED

The work described in this report to this point is necessarily
highly preliminary. There are a number of immediate next steps
that are needed to address some critical issues necessary in ap-
proaching the subject of procurement automation in a carefully
structured manner.

Improve Accuracy of Payoff Numbers

This present report suggests that large magnitude savings are
potentially possible. However, these early numbers were based upon
some relatively gross subjective estimates. Further refinement of
these estimates is both possible and desirable. Therefore, we
suggest that one task needed is to draw up finer, more disaggregated
components together with a specific proposed system description to
permit a more accurate estimate of potential payoffs.

53

Perform Manpower Analyses

1. Prepare time budgets by worker category in procurement. How much time does each person in each category spend in each of a number of component tasks?

2. Explore the feasibility of exchanging time at a computer terminal for each of the component tasks.

3. Generate a series of user activity profiles that permit determination of common computer-base' applications.

4. Determine which early capabilities will have the highest payoff.

Perform Initial Systems Synthesis

1. Determine first-cut set of user application software -- text editors and data base maintenance programs.

2. Create a test "fill-in-the-form" program for data capture, etc. This program would permit a non-computer terminal person to effectively interact with a large database almost solely via a question and answer interaction.

3. Perform a first-cut operating system design.

4. Estimate response times for various user loads and tasks.

5. Perform first-cut design on an intelligent terminal tailored for procurement automation purposes.

6. Expand the multiprocessor throughput model and use it to evaluate the proposed procurement automation system hardware configuration.

7. Determine the optimum division of processing tasks between either or both the terminal and the procurement automation system center.

8. Perform a first-cut design on system architecture:
   a. processor architecture (choice of appropriate processor)
   b. hardware/software for file handling
   c. memory hierarchy
   d. paging structure
   e. fault diagnosis and security

9. Prepare a first-cut design on communication system and its protocols.

Perform Initial Steps for Later System Integration

1. Describe hypothetical desired end system in detail.

2. Develop a general plan time-staged for integrating proposed system with other procurement automation systems.

3. Develop a detailed overall very long range phased plan.

4. Create a test bed demonstration of use of a terminal for automating some procurement functions including:

a. preparation of complete contracts with automatic boilerplate

b. use of reasonable human factors to match non-computer user's needs.

APPENDIX A

COST-BENEFIT ANALYSIS
OF PROCUREMENT AUTOMATION

CONTENTS

During the course of its studies, Cabledata Associates
focused on procurement as an area where computer technology and
computer networking could possibly produce significant savings
or improvements in effectiveness to the Defense Department. This
appendix quantifies the costs and benefits associated with the
hypothetical procurement automation system discussed in this
report.

We have factored the tangible payoffs to be found from
procurement automation into four components. These are: labor
savings; savings from earlier use of cost-declining technology;
savings due to the opportunity cost of capital; and savings from
improving the competitive marketplace. In the following, we
shall show that in the aggregate over a billion dollars a year
could be saved through procurement automation, at a cost of
about $45 million per year, or a benefit-cost ratio in excess
of 20:1.

METHODOLOGY

The methodology used in this study for estimating benefits
is the concept of alternative costs. We assume that costs
saved through procurement automation represent true savings in
resources and thus can be counted as real benefits. We further
assume that cost savings will not themselves induce any substan-
tial increase in procurement activity. If we keep the induced
increase in demand for procurement services fixed, then there can
be no additional costs or benefits associated with any increase.

In some cases a rate of interest has been assumed for the opportunity cost of money, for purposes of estimating the present value of certain changes in the timing of procurements. Although the country is currently passing through a period of record inflation, we have assumed an equivalent interest rate of eight per cent. We chose this particular rate because we use present value or current dollars, rather than inflated dollar figures in our estimates and do not believe recent very high interest rates are a normal state.

Our procedure is to categorize procurement by type of procurement. We limit our analysis to the data for FY 1973,[*] which is representative of DoD procurement spending. Given the dollar spending in each area, we estimate the fraction of this amount which would be affected by automation. Summing these effective savings over all types gives an estimate of total savings. We add spending for research, development, test and evaluation (RDT&E) to procurement spending only in those cases where we think it likely that such RDT&E procurements will also be affected by automation.

Each table in this appendix contains some subjective judgments. The reader may or may not agree with these estimates. In such cases, the reader is urged to replace any such estimate with his own judgment and then recompute the totals. In any event, we believe that the end conclusions will be somewhat similar: the size of the potential saving far exceeds the anticipated costs shown in the tables.

Each of the next four sections discusses the detailed evaluation of savings, one point at a time.

LABOR SAVINGS $77 MILLION PER YEAR

Approximately 61,000 procurement personnel are paid annually over $800 million in salaries. The distribution of these salaries by GS grade is shown in the first three columns of Table A-1.

----

[*] Source: Office of the Assistant Secretary of Defense (Comptroller), *Military Prime Contract Awards & Subcontract Payments or Commitments: July 1972 - June 1973*, March 1974.

TABLE A-1

ASSUMED LABOR SAVINGS AS A
FUNCTION OF LABOR GRADE

Grade	#	Salary,$M	% Time Saved	Potential $ Saved
Exec	5	.216	0	0
18,17	2	.072	0	0
16	143	4.919	2	.098
15	65	2.088	5	.104
14	1556	43.385	10	4.338
13	4011	95.371	15	14.306
12	6113	107.714	15	16.155
11	6987	117.881	15	17.682
10	663	10.200	10	1.020
9	7204	100.812	10	10.081
8	1246	15.805	5	.790
7	5660	64.880	5	3.244
6	3639	37.599	5	1.880
5	8723	80.783	5	4.039
4	8680	71.853	5	3.593
3	5487	40.444	0	0
2	1054	6.885	0	0
1	149	.859	0	0
Total	61,387	801.766		$77.330 MILLION

Average saving = 9.6%   Average saving = $13,060

Source: *Department of Defense Fiscal Year 1975 Budget (Appendix)*, p. 964 and pp. 977-980.

The procurement automation system which we have described will principally affect the middle grades of the civil service. These levels are equiv. lent to grades GS-11 through GS-13. In addition, we anticipate that substantial numbers of employees in grades GS-4 through GS-10 will also find some of their time

saved through procurement automation. The choice for the additional impact in the higher grades is based on the assumption that the tools proposed for automating systems procurements principally will affect the efficiency of management functions very much more than clerical functions.

In Table A-1, column 4 shows our estimates of the time which could be saved by each level of the procurement hierarchy. Average saving in time is 9.6%, or about 46 minutes per person per day. Based on actual expenditures, this would amount to a saving in current dollar terms of $77.33 million per year.

Notice that the estimated time saved is not the same as the estimated time which we believe procurement personnel will spend interacting with their computers. The typical time interacting with the computer is about an hour per day per person.
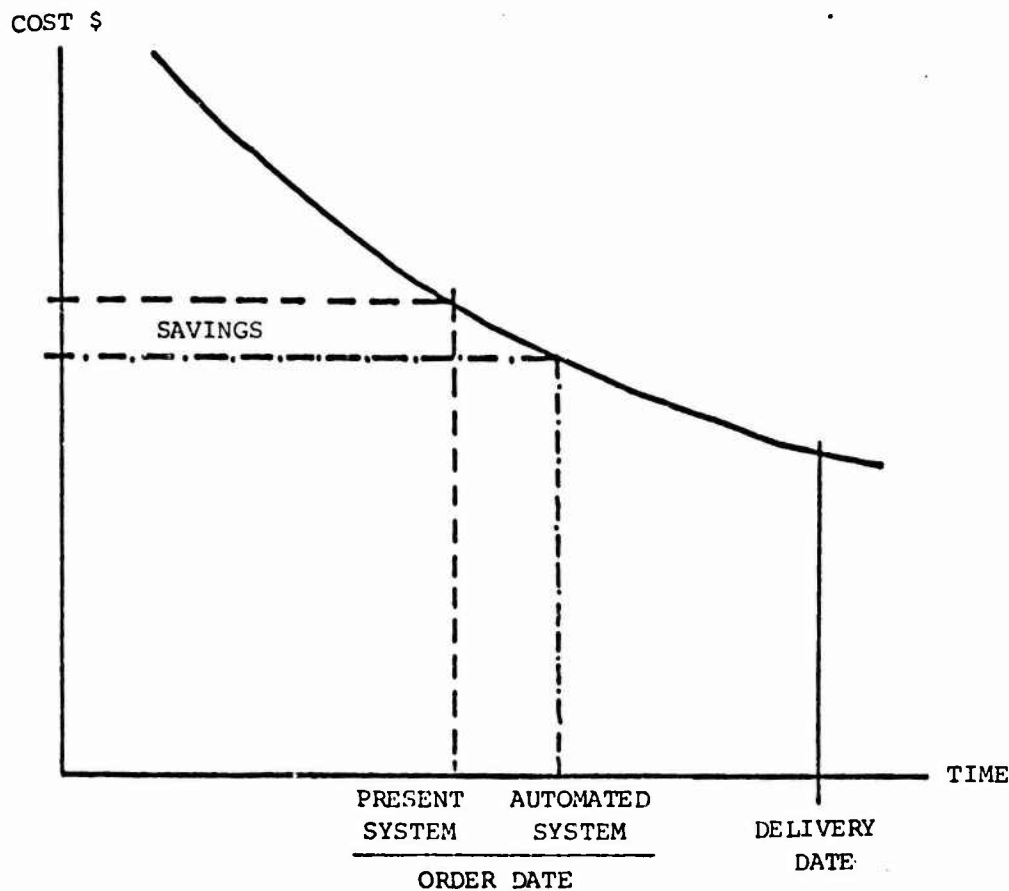
Figure A-1. Savings attributable to use of later (cost-declining) technology.

A-4

Automation of procurements for cost-declining high technology goods can result in substantial savings to the government. It allows the government, in effect, to place its order for the item at a later point in the technology's development. Figure A-1 illustrates the way in which this effect is translated into a cost saving.

In any procurement system there is a delay between the time when goods are wanted and the time they arrive. If the system requires a long lag for order processing well in advance of the time of delivery, to obtain an item by a particular delivery date the order must be placed at some earlier point in time at a cost shown by the descending curve. If through automation it is possible to move to a "can order" date which is later in time, advancing technology will result in lower costs. Imagine a hypothetical procurement system, say today's. If it takes X months from the time the goods must be ordered to the date needed, T, another system that requires only X-3 months will permit a saving if we are dealing with goods whose price is tumbling. Of course, few things in our economy are doing that right now, but certain types of high technology, such as integrated circuitry, are among them. Today's calculator can be purchased for less than one bought earlier on a lay-away plan. The Defense Department is a major purchaser of cost-declining technology items.

To estimate the amount of savings, we first must look at the types of items which are procured, and estimate the fraction of the components which involve cost-declining technology.

Table A-2 starts with itemized categories of procurement expenditures. Column 4 contains subjective estimates of the per cent of components in contracts by item which involve cost-declining technology. These are generally the areas of electronics, communication equipment, and missile and space systems, which make heavy use of integrated circuitry. Here a significant amount of money is involved in cost-declining activities. In many other

TABLE A-2

SAVINGS DUE TO REDUCING LEAD TIME FOR HIGH TECHNOLOGY COST-DECLINING TECHNOLOGY

Item	Procurement spending ($,Millions)	RDT&E spending ($,Millions)	Subjective estimates of percent of components in contracts involving cost-declining technology	Subjective estimates of percentage cost reduction per year due to use of later technology	Percent potential saving	Cost saving($/M) attributable to use of current instead of year-old technology (no RDT&E)
Airframes & engines	6544	1454 e	10	10	1	65.44
Other equipment, supplies & spares	1007	224 e	30	10	3	30.21
Missiles & space systems	4973	1687	30	20	6	298.38
Ships	2277	335	5	5	.25	5.925
Tank/automotive	651	54.6	5	5	.25	1.62
Weapons	350	91.5	10	5	.5	1.75
Ammunition	2583	89.2	0	0	0	0
Electronics and communication equipment	3700	1124	50	20	10	370.0
Services	2710	521	0	0	0	0
Subsistence, textiles, clothing & equipage	1167	2296	2	0	0	0
Fuels & Lubricants	976	0	0	0	0	0
Miscellaneous hard goods	1155	35.1	0	0	0	0
Total hard goods	28,093	7911.4	---	---	---	
Construction	1667	.6	0	0	0	0
Actions under $10,000	3246	21.9	0	0	0	0
Educational & non-profit	751	610	0	0	0	0
Intragovernmental	2525	16.5	0	0	0	0
Work outside U.S.	2009	25.0	0	0	0	0
Total (or average)	38,291	8585.4	---	---	---	1 year $773.325/M
						6 mos. $386.66/M
						3 mos. $193.33/M
(1)	(2)	(3)	(4)	(5)	(6)	(7)

e = estimate

A-6

areas, such as construction and the procurement of subsistence, textiles, clothing and equipage, we believe that there is some, but very little, cost-declining technology expenditures.

Column 5 shows subjective estimates of the percentage rate of cost reduction possible per year due to the use of improved technology. These estimates are based essentially on the average observed rates of technical progress in the industries represented by the items in the column. For instance, overall rate of fall in costs in electronics and communication equipment is estimated to be 20% per year, although certain sectors of the industry show historical rates of as much as 60%.

Column 6 is the product of columns 4 and 5, and suggests the potential saving possible due to the reduced lead time for each item in the table.

Column 7 contains the estimated cost savings attributable to the use of technology with a one-year reduction in lead time. The total saving if one year can be saved is $773.325 million. This number must be reduced proportionately if the saving anticipated is of shorter duration. Thus, a six-month saving is $386.66 million, and the three-month saving is $193.33 million. A three-month saving represents approximately 0.4% of the total procurement spending.

Figure A-2 summarizes the cash flows and sketches the nature of the calculation described.
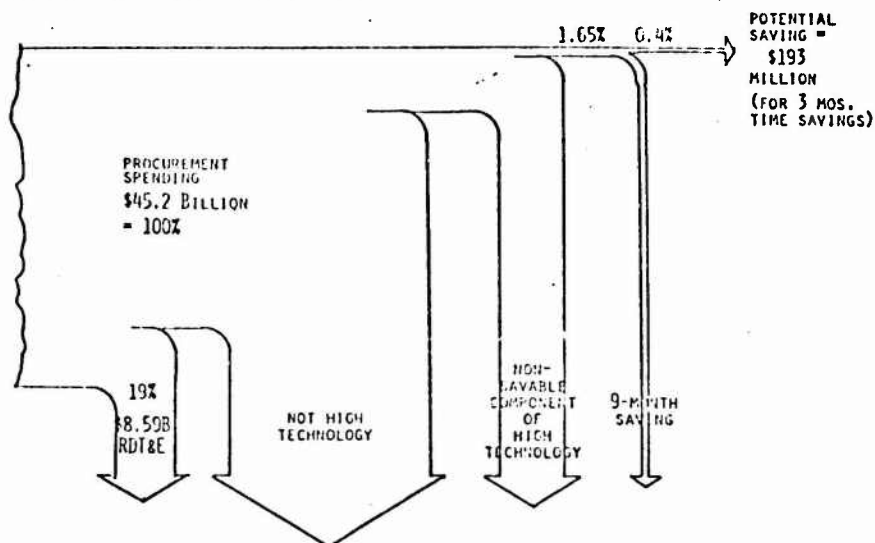
Figure A-2. Cash-flow diagram showing the savings attributable to reduced procurement delays.

In addition to the savings in lead time valued above, we
anticipate that the introduction of automation into systems
procurement will result in a savings due to an average reduction
in the duration of procurement and production for an item. We
believe that a four-month reduction is quite possible for the
very large systems procurements, with at least half to two-
thirds of this coming from the reduction of the length of time
required in the procurement cycle itself. Many of these savings
will result from the increased parallelism implicit in the auto-
mated system, which will replace current serial procedures.

In economic terms, the savings due to this change can be
valued in a manner somewhat similar to the way that the savings
due to an improved inventory management system would be valued
in private industry. The same money, if not tied up in a commit-
ment, would be able to be committed to some other purpose. There-
fore, the opportunity cost of this money may be thought of in
terms of interest the government would have to pay. The basic
saving here is a one-time gain. Once the long pipeline is
drained, there is no further saving. However, we convert this
one-time saving into interest on this equivalent amount of money
to annualize the savings from this source and make it compatible
with the basis for describing the other components of savings.

In Table A-3, column 2 and 3 repeat the information contained
in Table A-2.

Column 4 shows a subjective estimate of the per cent of
dollar volume which can be affected by a shortening of procure-
ment time. In particular, the percentage represents the effec-
tive fraction of procurements whose times can be compressed by
four months.

As RDT&E procurements may not be amenable to some of the
mechanisms which would shorten procurement lead time, column 5
is the product of columns 2 and 4 only. It represents a subject-
ive estimate of the amount spent during a four-month period which
could be eliminated by the one-time shortening of procurements
expressed as an annual rate.

TABLE A-3

OPPORTUNITY COST OF INTEREST VALUE OF ONE-TIME SAVINGS DUE TO AN
AVERAGE 4-MONTH REDUCTION OF PROCUREMENT + PRODUCTION TIME

Item	Procurement spending ($,Millions)	RDT&E spending ($,Millions)	Subjective estimates of percent which can be affected by shortened procurement time*	Subjective estimates of shortened procurement time $,Millions in pipelines annually (no RTD&E)	4-month pipelines compression, $	Value of 4 months money at 8% = 2.67%
Airframes & engines	6544	1454 e	40	2617.6	872.3	23.26
Other equipment, supplies & spares	1007	224 e	50	503.0	167.6	4.47
Missiles & space systems	4973	1687	30	1491.9	497.3	13.26
Ships	2277	335	25	562.2	189.73	5.06
Tank/automotive	651	54.6	20	130	43.3	1.15
Weapons	350	91.5	30	105	35.0	.93
Ammunition	2583	89.2	10	258	8.6	.23
Electronics and communication equipment	3700	1124	60	2220	740	19.73
Services	2710	521	20	540	1620	43.20
Subsistence, textiles, clothing & equipage	1167	2296	20	233.4	77.8	2.07
Fuels & lubricants	976	0	0	0	0	0
Miscellaneous hard goods	1155	35.1	10	115.0	38.3	1.02
Total hard goods	28,093	7911.4				
Construction	1667	.6	30	500.1	166.7	4.45
Actions under $10,000	3246	21.9	0	0	0	0
Educational & non-profit	751	610	20	150.2	50.0	1.33
Intragovernmental	2525	16.5	0	0	0	0
Work outside U.S.	2009	25.0	20	401.8	133.9	3.57
Total (or average)	38,291	8585.4			4 mos.	123.73
					3 mos.	92.80
(1)	(2)	(3)	(4)	(5)	(6)	(7)

*Estimating average time = 4 months.

e = estimate

A-9

One-third of this number is shown in column 6 as the effect of a four-month compression. This amount, in turn, is valued at 8% in column 7, to give the interest saving due to a four-month shortening in procurement and production time. Such a four-month saving results in a $123.7 million saving to the government. Should it develop that only three months can be saved, the savings are still almost $93 million.

Figure A-3 shows a cash flow diagram describing the above cited calculator.
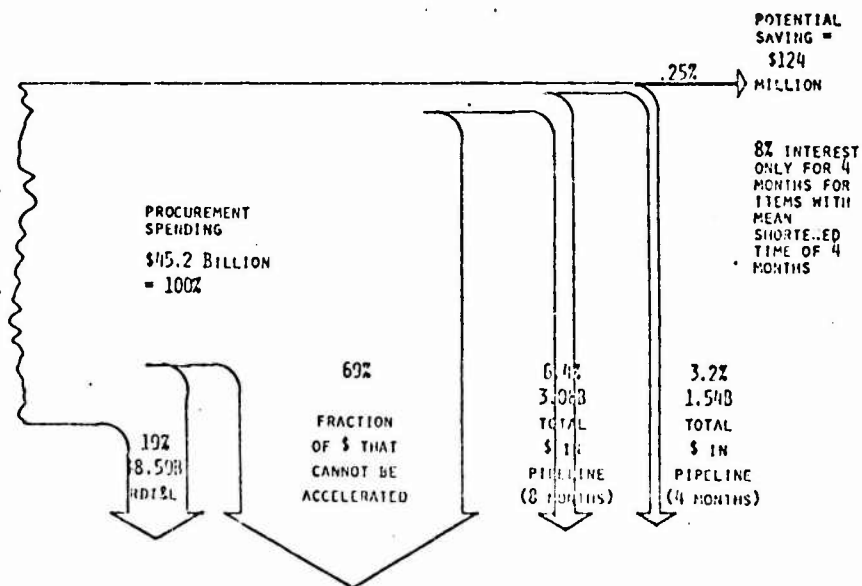
Figure A-3. Opportunity cost of capital.

IMPROVING COMPETITIVE MARKETS, $778 MILLION/YEAR

Figure A-4 illustrates the fraction of procurements which take place in the current system by a non-competitive means. We believe that the increased use of information storage and retrieval systems can make it possible to extend significantly the scope of competition in procurement. This is not to say that formal advertising and other current methods will be more widely used; rather, that entirely new systems, such as BROKER* could be

----

*
Carson E. Agnew, "Proposed Applications for a Procurement Automation System," in ARPANET MANAGEMENT STUDY: New Application Areas, Cabledata Associates R-160 (NTIS AD #787039), August 1974, Appendix B.

COMPETITION IN MILITARY PROCUREMENT
JULY 1972 - JUNE 1973

PERCENT OF TOTAL PROCUREMENT
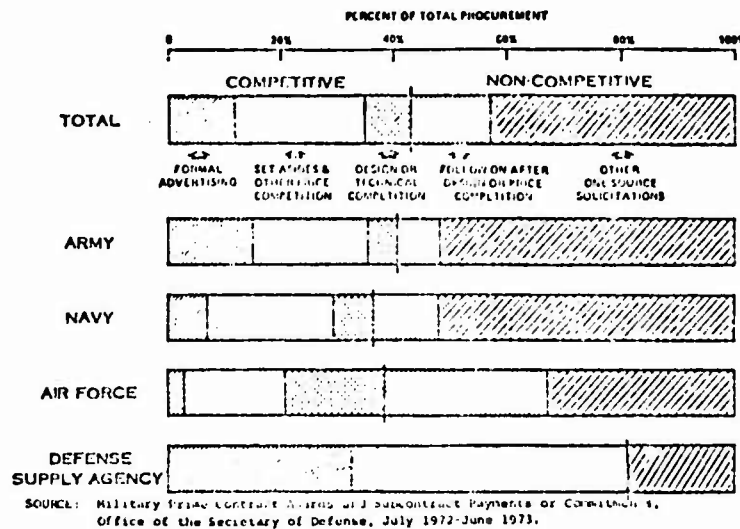
Figure A-4.

developed to enable wider and more complete information to be
gathered about potential competitors. Such information would
enable more competitive decisions to be made without the waste-
ful duplication of an excessive number of over-prepared proposals
sometimes seen at present. Even in negotiated environments sav-
ings could be made, by permitting procurement officers to better
choose firms from which to solicit proposals. Furthermore, we
believe that such systems will make it possible to break up
large systems procurements into many small, more manageable com-
ponents. This, too, promotes competition as well as having the
effect of smoothing the flow of work through the nation's def-
ense industries. The feast-or-famine life of defense contractors
takes its toll in building up overhead costs -- which the govern-
ment must pay, one way or another. There is no Santa Claus.

Present government contracting machinery focuses on cost
and not on prices. By opening up potential procurements by type
of good procured to a wider base of potential bidders, some of
the tendency to sole-source procurement could be diminished. Com-
petition, not sole-source, is an undisputed national policy. For

example, the U.S. Supreme Court noted in 1967:

> *The unrestrained interaction of competitive forces*
> *will yield the best allocation of our economic resources,*
> *the lowest prices, the highest quality, and the greatest*
> *material progress, while at the same time providing an*
> *environment conducive to the preservation of our demo-*
> *cratic political and social institutions.**

With well over half of the procurement dollars going into
the non-competitive sector (see Table A-4), there is little or
no question that movement to competition would be in line with
overall national policy. To us, the most important question
relating to improving competition is: how much can be saved?
In a recent study of twenty large procurements,** learning curves
were estimated and used to correct estimates as to whether nego-
tiation resulted in a lower total cost than formal advertising.
The study showed an average savings due to advertising of 50%,
with a standard deviation of 19.3%. Other testimony has indi-
cated savings in the range of 30% to 40% for competitive procure-
ments.*** In our tabulation we use the conservative assumption
that automation will enable a realization of a maximum of only
25% of savings, rather than 50%, as cited above. And, that this
saving could occur in a very limited set of cases.

----

*Communication News, November 1974, p. 30.

**Larry Yuspeh, The general advantages of competitive procure-
ment over sole source negotiation in the Defense Department, A
study prepared for the use of the Subcommittee on Priorities and
Economy in Government of the Joint Economic Committee, Congress
of the United States, November 12, 1973. Full text reprinted in
"The Acquisition of Weapons Systems," Hearings before the Sub-
committee on Priorities and Economy in Government, Part 7,
pp. 2598-2624, Washington, D.C.: Superintendent of Documents,
November 1973.

***The following discussion occurred on 16 November 1973 dur-
ing hearings on the acquisition of weapons systems, before the
Subcommittee on Priorities and Economy in Government, of the Joint
Economic Committee. Participants were Senator William Proxmire,
Chairman of the Subcommittee and Vice Chairman of the Joint Com-
mittee, Mr. A. I. Mendolia, Assistant Secretary of Defense (In-
stallation and Logistics), and Mr. Jack L. Bowers, Assistant
Secretary of the Navy (Installations and Logistics):

In Table A-4, column 2 contains procurement spending by type of procurement.

In column 3 we eliminate the estimated component of procurement spending which is already competitive.

Column 4 is a subjective estimate of the fraction of contract funding which could be affected by improved markets by type, considering only non-competitive procurements.

The annual savings using either the 50% or 25% assumption are shown in columns 5 and 6. Under the 25% assumption, savings due to competition total $778 million annually.

Figure A-2 shows a sketch of the cash flows.

DISCUSSION

This is a lot of money, and further discussion on this point is indicated.

Chairman PROXMIRE. We all agree on the principle that we should move to competition. I am sure that is the sentiment of the Congress and the sentiment of the administration, too.

Mr. BOWERS. Absolutely.

Chairman PROXMIRE. But we somehow cannot seem to do it rapidly enough. There are so many forces that work the other way to counteract competition. Competition is always a cruel, painful discipline. And it is the discipline that enables our private system to work so well. And it is the lack of that which is one of the principal factors that is the reason why our public activities are so relatively costly. So we would like to just press it as hard as we can. I do not see any evidence, even on the basis of Mr. Mendolia's presentation on competition, that we have nearly enough of our procurement in competition. We have people like Admiral Rickover, whom all of you admire, who tell us over and over again that we should procure far more of our systems on a competitive basis. He says his experience is that competition consistently reduces cost between 30 and 40 percent, is what he told me.

Now, I see you are smiling Mr. Mendolia. Would you like to reply to that?

Mr. MENDOLIA. Well, I keep hearing numbers like that, and

A-13

Table A-4

COST SAVINGS POTENTIALLY AVAILABLE TO IMPROVED MARKETS*

Item	Procurement spending (includes RDT&E) ($,Millions)	Estimated non-competitive component (56.8%)	Subjective estimates of percent of contract $ which would be affected by improved markets (non-competitive % only)	Annual savings due to improved markets ($,Millions) 50%+ assumption	25% assumption
Airframes & engines	7998	4543	10	227	114
Other equipment, supplies & spares	1231	716	15	54	27
Missiles & space systems	6660	3783	20	378	189
Ships	2612	1484	25	186	93
Tank/automotive	706	401	5	10	5
Weapons	442	251	10	13	7
Ammunition	2672	1518	5	38	19
Electronics and communication equipment	4824	2740	30	411	205
Services	3231	1835	10	92	46
Subsistence, textiles, clothing & equipage	3463	1967	10	98	49
Fuels & lubricants	976	554	0	0	0
Miscellaneous hard goods	1191	677	0	0	0
Total hard goods	36,006	20,451			
Construction	1668	947	10	47	24
Actions under $10,000	3268	1856	0	0	0
Educational & non-profit	1361	773	0	0	0
Intragovernmental	2542	1444	0	0	0
Work outside U.S.	2034	1155	0	0	0
Total (or average)	46,879	26,627		$1554/M	$778/M**
(1)	(2)	(3)	(4)	(5)	(6)

*Assumes Joint Economic Committee study estimates are valid ... $1554/M

**Assumes Joint Economic Committee study estimates are only half valid....... $778/M

Effect of Procurement Size on Competition

As elsewhere described in this report, competitive procure-
ments are primarily used for small orders of standardized items.
Systems procurements made under the present system are largely
awarded on a non-competitive basis. The reasons are that
procurements are held to be non-standard, or contain complex
technology, or because the number of potential responsible

I hear it in the Pentagon, that competition reduces costs by 30
or 40 percent. And my view is, where are these companies that
make 30 or 40 percent profit margin? In other words, to me
there are two factors --

Chairman PROXMIRE. That is a very good point. I raised
that point yesterday. I said, after all, if you do have a situ-
ation where there is a 30 or 40 percent amount here, why is it
not reflected in profits?

Mr. MENDOLIA. That is right.

Chairman PROXMIRE. The answer to that that was given yester-
day was reasonable. They said, it is eaten up really in addition-
al costs. You do not have the pressure to hold down your costs
when you do not go competitive. You have a tendency to push
your overhead into the Government sector from your private sec-
tor operations. And you have all kinds of other reasons to hold
onto your manpower when you have less competition and not the
pressure and discipline of competition.

Mr. MENDOLIA. That was going to be my second point. To me
the thing that the competition does is that it causes each of
the competitors to improve his process to reduce cost, and there-
by comes the cost reduction. What I would hate to see implied
is that there is a 30 or 40 percent profit that suddenly disappears
simply because you introduce competition. It is hard to deny
that competition is a very effective force.

Source: The acquisition of weapons systems,
*Hearings Before the Subcommittee on
Priorities and Economy in Government,*
of the Joint Economic Committee, Con-
gress of the United States, Ninety-
third Congress, First Session, Part 7,
Washington, D.C.: Superintendent of
Documents, 1974. Price $2.25.
(pp. 2756-7.)

bidders is "too few." We believe that the reasons cited are
more likely to be statements of symptoms than descriptive of the
ailment itself. The fact that fifty per cent of a large con-
tract's dollar volume is re-awarded as subcontracts makes it seem
unlikely that size or complexity need be a barrier to competi-
tion. Yuspeh's study[*] included several complex pieces of high
technology electronic equipment fully corrected for learning
curves and indicated competitive savings of the same size as
for other types of equipment.

Nevertheless, we believe that there exists a good but un-
stated reason for the use of non-competitive methods in systems
procurements. Namely, that the information and information
processing capability which DoD requires to manage a few large
contracts is much less than would be required for many small
competitive contracts. With our present relatively unautomated
procurement system, the cost of obtaining and using information
is so large as to make a few procurements preferable to many.
One unavoidable consequence of this preference is the large
dollar value of each procurement action. And, a result of this
is to necessarily limit the number of firms who are large enough
to bid effectively for any system task. The existence of large
procurements may act as a barrier to the entry of more effective
firms into specialized defense markets in the same way that any
scale effect does in the private sector. The observed absence
of competition for large procurements thus may be a consequence
of the way in which these procurements are managed, rather than

----

[*] The response to this testimony by DoD representatives was
relatively limited. The strongest argument made by them was
that Yuspeh took an insignificant percentage of all procurements
into account, so that the total results were not valid. On the
other hand, Yuspeh's method of selecting his test cases did not
appear to be obviously "fudged" to produce the information he
sought. Further, no countercase was made that non-competitive
actions were in fact less costly to the government. Clearly,
this is an important subject and very much in need of more
analysis.

vice-versa. However, once a lack of potential competitors is
noted, the observation reinforces the tendency toward managing
a few large procurements.

This economically inefficient cycle can, we believe, be
broken if the costs of managing individual procurements can be
reduced. In particular, the automated system which we have been
discussing seeks to reduce these costs by automating the pro-
cessing of the routine information associated with a procurement
and by improving or augmenting the capability of procurement
officers to make good decisions. Thus, one of the goals of the
procurement automation system is to make it possible for DoD
to fracture large procurements into small ones, as is now done
by contractors anyway. Smaller procurements will lower the mini-
mum effective size which a firm must have in order to bid, smooth
the flow of work passing through companies already large, and
allow the use of companies with skill capabilities better tail-
ored to the tasks needing to be done (rather than having to deal
with very large defense contractors marginally capable in every-
thing, but usually only strongly competent in one or two spec-
ialties.) There may be increased systems integration costs involved
but we believe them to be minor in light of the potential savings
possible. The benefits of competition to the buyer are clearly
understood in the literature of economics. Also understood are
the payoffs lowering the maximum economic efficiency scale size.
The new management tools possible with computer netting may per-
mit us to restructure the procurement process so as to permit cap-
ture of these potential savings.

INTANGIBLE BENEFITS

In addition to the four tangible benefits we have described,
we believe that substantial intangible benefits also exist. And
the importance of these may match or exceed the more readily
measured tangible benefits. These intangible benefits may be
divided into internal and external components. Internal benefits
would include:

    o Increases in the span of control by procurement
      management:

- Increases in the knowledge of the history
  of any procurement

- Aggregated statistics on demand

- Smaller, more efficient staffs

o Makes possible rearrangement of personnel without
  physical relocation.

o Permits on-line training using computer-aided
  instruction.

External benefits are those which accrue to entities other than the Department of Defense. We believe that procurement automation:

o Allows better planning by industry, eventually
  meaning reduced costs to the government

o Conforms with congressional desires and pressures
  for more truly competitive bidding

o Meets new Freedom of Information Act requirements
  without additional clerical burden

o Provides better audit trails, discouraging favor-
  itism and dishonesty.

And most important of all:

o Permits faster response in critical military
  situations

Of course we have no way of estimating the value of these benefits, or other benefits which might accrue from procurement automation. Nevertheless, in the next section we will show that the costs are of such magnitude that these intangible benefits need not be considered in order to cost-justify procurement automation.

COSTS OF THE PROCUREMENT AUTOMATION SYSTEM

The principal components of the procurement automation system will be the multiprocessor large memory systems described in the First Quarterly Technical Report of this project.*

----

*"Preliminary Design for Procurement Data Base System Hardware Configuration," *ARPANET MANAGEMENT STUDY: New Application Areas*, Cabledata Associates R-148 (NTIS AD #783508), May 1974, Appendix I.

The system would include six to eight processors working through a memory hierarchy of modular solid state memory, swapping disks, mass storage and a large archival store. Each such system should be capable of serving approximately 1000 users doing the highly specialized tasks associated with procurement.

The computer communications system which we have considered on a preliminary design basis does not reproduce the capabilities of any system currently on the market. The system must be able to handle an average of 1000 terminals per site, or 11,000 out of 22,000 terminals in all. Such a system will make heavy use of intelligent terminals to take the load off the main system, and new multiprocessor architecture for advanced reliability and effectiveness. Entirely new software, including operating systems, will be required for this machine. The machine will be specialized for procurement functions and will in fact be unsuitable for general purpose computation. The access to a wideband computer network permits any needed special functions to be executed on a machine most suited for that function. The systems used in the procurement automation system, in addition to their special purpose software, will have built-in privacy, security and user controls. We believe that such systems can be built and installed incrementally on a center-by-center and function-by-function basis, because of their modularity.

Table A-5 contains a cost estimate for the overall procurement automation system. This system, of course, includes not only the central computer installations, but user terminals, communication lines and software support and development. Table A-6 contains our estimates of the unit cost, number required, capital cost, useful life and annual cost of these components.

Including a 20% factor for contingencies and working in current dollars, we believe that the annual cost of the entire system will be $44.62 million. As indicated in the table, we believe that this represents a cost of approximately $2.70 per user hour for the level of usage projected by the estimates of manpower developed in Table A-1, and an average load per center

of 10,700 hours per day (approximately 975 users during an average hour).

Table A-5

COST ESTIMATE, PROCUREMENT AUTOMATION SYSTEM

	Unit cost	Number	Capital cost	Useful life*	Annual cost
Central computer installations (See Table A-6)	$ 2,977,000	11	$ 32,747,000	4	$ 8,186,750
Intelligent terminals	$1,000	22,000	$22,000,000	4	$5,500,000
Communications (4 terminals/clump @ $720x4 = $2880/yr)	$720/yr	22,000	----	-	$15,840,000
Software 100 programmers x 5 yrs	$35,000	500	$17,500,000	5	$3,500,000
Administration 100 people Overhead, training and documentation	$35,000	100			$3,500,000
Building space 200 people x 200 ft x 11 computer sites 3000 sq ft	$9	73,000	----	-	$657,000
				Total	$ 37,183,750
		+ 20% contingencies and omissions			7,436,750
				Total	$ 44,620,500

Reasonableness check: 66,000 users X 1 hour per day X 250 working
= 16,500,000 hours
$44,620,500/16,500,00 = $2.70/hr.
$/hour per user = $2.70

* Factor includes maintenance.

COST ESTIMATE, EACH CENTRAL COMPUTER INSTALLATION

1 Memory unit
  modular
    512K 16/32 bit words –
    Systems Concepts Corp.
  (same type as to be used in
   Illiac IV memory)
	$1,000,000

4 Disks, swapping media DDC #9113 @ $54,000	216,000

16 @ 7330 Mass disk (Itel)
  50 ms maximum, 20 ms average
  100 Megabytes @ $13,000
	241,000

6 or 8 @ $30,000 Processors	250,000
Archival Store, such as Ampex terabit w/14 transports + channels & cabling 6.44×10^{11} bits	720,000
Cabling, cases, consoles, flooring, etc.	300,000
1000 Modems/Concentrators	250,000
	2,977,000

BENEFITS VERSUS COSTS: 20+:1 RATIO

Table A-7 summarizes the tangible savings which we believe can be achieved through procurement automation. Over the four areas discussed above, we anticipate savings of over $1 billion annually. When compared with the estimated $45 million per year cost of the system, this represents a ratio of benefits to costs in excess of 20:1. This is in fact an extremely large benefit-cost ratio. The ratio is so large that it implies that *the overall desirability of the automation of systems procurements is almost completely insensitive to the actual estimates of benefits and costs presented here.* A change in either benefits

TABLE A-7

TOTAL TANGIBLE SAVINGS

o	IMPROVED COMPETITIVE MARKETPLACE	$ 778 M
o	EARLIER USE OF LATER TECHNOLOGY	193 M
o	REDUCED PROCUREMENT DELAYS	124 M
o	LABOR SAVINGS	77 M
	TOTAL:	$1,172 M

or costs by even an order of magnitude would still provide a rather significant saving. (And, we do not believe that our estimates are amiss by nearly that amount.)

Further refinement of these numbers is both possible and desirable, but this will require more disaggregation and the knowledge of a specific proposed system definition. In particular, it will be possible to refine estimates of costs and benefits only when a particular procurement command or application has been chosen for study for automation. And this will require completion of in-depth studies both in the way in which procurement is really carried out within the Department of Defense, and how alternative arrangements might work. Based upon evidence which we have compiled in this report, such studies will themselves be valuable in pinpointing the next steps in procurement automation.

SUMMARY

This appendix has presented a benefit-cost analysis of a single automation application -- procurement -- under this contract. Benefits were found to be in excess of a billion dollars annually, while costs for the total system were on the order of $45 million annually. We believe that these estimates are sufficiently close to the mark to suggest that increased new generation

technology for automation of procurement within the Department of Defense be seriously considered at the earliest possible date. There is a lot of money that can be saved.

The principal benefit is derived from the use of automation to introduce competition into system procurements. Increased competition results in part from a reduction in the average size of a procurement action by reduced information costs associated with an automated system. Direct labor savings associated with automation can contribute only a small increment to total benefits because automation changes the tasks which people perform much more than it changes the number of jobs required to accomplish a task.

APPENDIX B

TABLES OF CONTENTS OF
RELATED PAPERS

TABLE OF CONTENTS

VOLUME II

B-2

CONTENTS

l

CABLEDATA ASSOCIATES, INC.

701 Welch Road • Palo Alto, California 94304

R-148

AD783508

ARPANET MANAGEMENT STUDY:
NEW APPLICATION AREAS

FIRST QUARTERLY TECHNICAL REPORT

*This research was supported by
the Advanced Research Projects
Agency of the Department of
Defense and was monitored by
the Range Measurements Labora-
tory under Contract No.:
F08606-74-C-0043.*

ARPA ORDER NUMBER	CONTRACT NUMBER
2317, Amnd #2	*F08606-74-C-0043*
PROGRAM CODE NUMBER 4P10	PRINCIPAL INVESTIGATOR & PHONE NO. *Paul Baran – (415) 328-2411*
NAME OF CONTRACTOR *Cabledata Associates, Inc.*	PROJECT SCIENTIST & PHONE NO. *Vinton G. Cerf – (415) 328-2411*
EFFECTIVE DATE OF CONTRACT *1974 February 5*	SHORT TITLE OF WORK *First Quarterly Technical Report*
CONTRACT EXPIRATION DATE *1975 February 4*	DATE OF REPORT *1974 May 5*
AMOUNT OF CONTRACT *$183.656.00*	CONTRACT PERIOD COVERED BY REPORT *1974 February 5 – 1974 April 30*

*The views and conclusions contained in this document are those of the
authors and should not be interpreted as necessarily representing the
official policies, either expressed or implied, of the Advanced
Research Projects Agency of the U.S. Government.*

5

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1 REPORT NUMBER R-148	2. GOVT ACCESSION NO. AD 783508	3. RECIPIENT'S CATALOG NUMBER
4 TITLE (and Subtitle) ARPANET MANAGEMENT STUDY: NEW APPLICATION AREAS (First Quarterly Technical Report)		5 TYPE OF REPORT & PERIOD COVERED Interim Technical Report 1974 February-March-April
		6. PERFORMING ORG. REPORT NUMBER
7 AUTHOR(s) Carson E. Agnew, Paul Baran, David C. Caulkins, Vinton G. Cerf, Ronald C. Crane, Edwin B. Parker		8. CONTRACT OR GRANT NUMBER(s) FO8606-74-C-0043
9 PERFORMING ORGANIZATION NAME AND ADDRESS Cabledata Associates, Inc. 701 Welch Road Palo Alto, CA 94304		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS ARPA Order 2317/2
11. CONTROLLING OFFICE NAME AND ADDRESS Advanced Research Projects Agency 1400 Wilson Bl Arlington, VA 22209		12. REPORT DATE 1974 May 5
		13. NUMBER OF PAGES 115
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Range Measurements Laboratory (ENL) Air Force Eastern Test Range (AFSC) Patrick Air Force Base, FL 32925		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution unlimited. Available from National Technical Information Service, Springfield, VA 22151

17 DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

-----

18 SUPPLEMENTARY NOTES

-----

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer-netting, procurement data base, automated aids to procurement, multiprocessing with minicomputers, procurement management, ARPANET, automation economics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Discusses new applications for computer-netting technology, developed by ARPA-IPTO, which has high payoff to DoD. Main thrust is on feasibility of automating certain routine data base/communications functions within defense procurement system. Target of work is potential dollar savings on the order of $100 million per year, and more rapid and effective procurement action under better defense management control. Also discusses procedures used in reaching the tentative conclusions; contains description of magnitude of the problem; and proposes preliminary hardware configuration design to allow more careful refining of parameters.

DD FORM 1473   EDITION OF 1 NOV 65 IS OBSOLETE

CONTENTS

7

ii

FIGURES

TABLES

CABLEDATA ASSOCIATES, INC.

701 Welch Road ● Palo Alto, California 94304

R-160

ARPANET MANAGEMENT STUDY: NEW APPLICATION AREAS

SECOND QUARTERLY TECHNICAL REPORT

This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by the Range Measurements Laboratory under Contract No.:
FO8606-74-C-0043.

ARPA ORDER NUMBER	CONTRACT NUMBER
2317, Amnd #2	FO8606-74-C-0043
PROGRAM CODE NUMBER 4P10	PRINCIPAL INVESTIGATOR & PHONE NO. Paul Baran - (415) 328-2411
NAME OF CONTRACTOR Cabledata Associates, Inc.	PROJECT SCIENTIST & PHONE NO. Vinton G. Cerf - (415) 328-2411
EFFECTIVE DATE OF CONTRACT 1974 February 5	SHORT TITLE OF WORK Second Quarterly Technical Report
CONTRACT EXPIRATION DATE 1975 February 4	DATE OF REPORT 1974 August 5
AMOUNT OF CONTRACT $183.656.00	CONTRACT PERIOD COVERED BY REPORT 1974 May 5 - 1974 July 30

B-12

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
R-160	AD 787039	

4. TITLE (and Subtitle)	5. TYPE OF REPORT & PERIOD COVERED
ARPANET MANAGEMENT STUDY: NEW APPLICATION AREAS (Second Quarterly Technical Report)	Interim Technical Report 1974 May-June-July
	6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
Carson E. Agnew, Paul Baran, David C. Caulkins Vinton G. Cerf, Ronald C. Crane, Paul Goldstein, Edwin B. Parker	FO8606-74-C-0043

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
Cabledata Associates, Inc. 701 Welch Road Palo Alto, CA 94304	ARPA Order 2317/2

11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE
Advanced Research Projects Agency 1400 Wilson Blvd Arlington, VA 22209	1974 August 5
	13. NUMBER OF PAGES
	195

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report)
Range Measurements Laboratory (ENL) Air Force Eastern Test Range (AFSC) Patrick Air Force Base, FL 32925	UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution unlimited. Available from National Technical Information Service, Springfield, VA 22151

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

-----

18. SUPPLEMENTARY NOTES

-----

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer-netting, procurement data base automated aids to procurement, procurement management, ARPANET, automation economics, computer secrecy protection, message transmission, computers, communications.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Overall project explores new applications for transfer of technology developed by ARPA-IPTO. Present report discusses technical and economic feasibility of widespread computer netting technology usage to aid DoD procurement effectiveness. Considers goals and objectives; technical and economic feasibility analyses, state of the art and technical and policy issues in preservation of secrecy in distributed computer based system design. Also examines costs of transmitting one-way messages using alternative technologies.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

13

CONTENTS

LIST OF FIGURES

B - 18

LIST OF TABLES

19

APPENDIX C

SURVEY OF PROCUREMENT AUTOMATION
SYSTEMS IN PRESENT USE

INTRODUCTION

The procurement automation effort being considered is an
advanced management concept, requiring a number of different
modules. A field survey of systems in being and systems in
design was conducted in Summer 1974. In the aggregate, many of
the modules or capabilities necessary to implement a procurement
automation system appear to be in place or in development.

Ten systems were surveyed. All are developing in a semi-
autonomous fashion; most are "mature" and fully operational.
Several more will be implemented in 1975. Among them they main-
tain an enormous database, dozens of computers, and a large
support staff. They serve hundreds of user sites, distributed
world-wide, and monitor procurement transactions worth billions
of dollars. The procurement automation "community" has accumu-
lated 10-15 years of direct experience with relevant management
and computer techniques.

A TYPOLOGY OF SYSTEMS

Various branches of DoD have shown awareness of procurement
automation needs since the early 1960s, when EDP systems were
developed on a relatively ad-hoc basis to solve spot needs. As
computing power increased and the availability of computing tal-
ent and acceptance became more general, the procurement EDP ac-
tivities grew in scope. The growth, a bottom-up phenomenon,
drew some early distinctions which appear to have survived until
today.

TABLE C-1

SURVEY OF RELEVANT PROCUREMENT AND CONTRACTING SYSTEMS

Short Name	Full Name	Abstract
ALS	Advanced Logistics System	Air Force. An integrated standard system designed to support the materiel management, procurement and related accounting and finance missions of the Air Force Logistics Command at AFLC Headquarters and the five Air Materiel Areas; will accomodate up to 150 remote stations for file up-date and inquiry; accommodates MILSCAP; will produce automated small purchases and some orders.
AMIS	Acquisition Management Information System	Air Force. A system designed to integrate in one file data required to support the procurement and contract administration missions of the Air Force Systems Command; will include finance and accounting support to include fund management and payment; will accommodate MILSCAP; will provide file up-date and inquiry capability in near real time made from 100 remotes stations.
AC	Avionics Central	DoD-wide info utility, servicing a number of databases such as R&D projects, Navy directives, U.S. Code, Auditor General, ASPR, etc.
CAIMS	Conventional Ammunition Information Management System	Navy. A system designed to support materiel management and procurement of conventional ammunition; supports 849 activities handling and reporting ammunition; does not support accounting and finance; accommodates MILSCAP; bulk of items controlled by Ships Parts Control Center (SPCC).
CCSS	Commodity Command Standard System	Army. An integrated materiel acquisition and control system providing data files and products for materiel management, procurement and accounting and finance; accommodates MILSCAP requirements; produces some automated contracts; cyclic inquiry capability.
CIAPS	Customer Integrated Automated Procurement System	Air Force. Logistic automated procurement for base support activities.
IMMS	Integrated Materiel Management System	Navy. A system under development for the Naval Ship Systems Command which has potential as a prototype standard system to support many systems commands; will accommodate MILSCAP; will interface with PARS and the FMIP in the financial area.
FLITE	Legal Information Through Electronics	Text-oriented information utility servicing DoD legal offices; databases include U.S. Code, ASPR, Court of Claims, etc.
MILSCAP	Military Standard for Contracting and Procurement	DoD-wide directive for internal and external standardization and integration of procurement MIS.
MOCAS	Mechanization of Contract Administration Services	DSA. A standard ADP system designed to support the contract administration mission of the DSA; accommodates a portion of MILSCAP; provides for payment of contractors' invoices.
PARS	Procurement Accounting and Reporting System	Navy. Designed primarily to support the requirements of the Assistant Secretary of the Navy for Financial Management for accounting and finance data, is expected to interface with IMMS, a proposed standard information system for Navy Ship Systems Command, and with a portion of UICP, ultimately.
SAMMS	Standard Automated Materiels Management System	DSA. A standard integrated ADP system designed to support the materiel management and procurement missions of DSA supply centers; interfaces with finance and accounting systems; accommodates MILSCAP; produces automated small purchases and some orders.
SMIS	Safeguard Management Information System	Army. A system in support of the Safeguard Missile System program; primarily designed to support project managers' and higher level echelons' requirements; interfaces with financial data system; five CRT terminals with inquiry and file update capability; accommodates MILSCAP.
UICP	Uniform Automated Data Processing System for Inventory Control Points	Navy. Provides ADP support for materiel management and procurement of logistics support items; file access daily file update by 128 remote stations; automated small purchases; features top-to-bottom file of items related to a system, in addition to Master Data File; supports accounting and finance; accommodates MILSCAP.

Branch-Oriented or DoD Wide?

Until the MILSCAP directive of 10 January 1968, the various procurement and contracting Management Information Systems were developed with minimal concern for DoD-wide communication. The merit of such a practice should not go unnoted; i.e., that the invention and implementation of new systems were allowed to proliferate in a manner that encouraged innovation. An early "freeze" on ideas would have restricted the variety of forms created, and good ideas would have been lost. By the mid-sixties, DoD realized that there had developed a plethora on the idea market, and that some forms would necessarily fail in competition. Again, this was a healthy stage -- less successful systems lost their claims on scarce computing and managerial resources, while the more successful ones were reinforced. We are now at the third stage of the process, with each branch developing healthy, effective systems. The selection decisions have moved up from the branch level to the OSD level. The next evolutionary phase will see branch-particular systems becoming generalized to DoD-wide application.

"Logistic" or "Systems" Commands?

For thoroughly sound organizational reasons, the early efforts in procurement automation drew a sharp distinction between logistic type support and major weapons system acquisition. The nature of the transactions was qualitatively different, and implied different approaches. Whereas the former was highly routinized, the latter was typically "hand massaged," unique, and not easily reduced to standard operating procedure. Therefore, the logistic and the systems command developed separate management information systems -- a situation still true today.

Internal or External Standards?

The key to successful coordination is the development and implementation of good standards. The system boundary, in fact, is defined by its nonconformity to the adjoining system's "language." This is true at every level of a hierarchy, whether at the office, lab, base, command, or branch level. Each branch experienced the problem as two-fold.

First, one must develop "internal" standards so that systems within the hierarchy can talk to each other. This has generally been conceived as intra-branch standardization (with the exception of DSA, which saw it as an intra-DoD problem).

Second, one must develop "external" standards to talk to parallel hierarchies. This has generally been conceived as inter-branch and branch-contractor standarization (except DSA, which understood it only as DoD-contractor standardization). The distinction remains with us today, that some systems are internal only and some are both internal and external.

The procurement automation system (discussed elsewhere in this report[*]) can be seen as (a) DoD-wide, (b) systems command plus logistic support procurement and contracting system, which (c) has both internal and external interface capabilities.

A Catalog of Procurement Systems

The procurement activities in DoD are currently supported by fourteen major automated systems, plus a large number of small (base oriented) management information systems. Seven systems are logistic oriented, four are system oriented, and three serve DoD-wide.

The systems we surveyed are developing in a semi-autonomous fasion; most are "mature" and fully operational. Several more will be implemented in 1975. Among them they maintain an enormous database, dozens of computers, and a large support staff. They serve hundreds of user sites, distributed world-wide, and monitor procurement transactions worth billions of dollars. The procurement automation "community" has accumulated 10-15 years of direct experience with relevant management and computer techniques.

----

[*] See Volume I, Section 2, this report, and Appendix A, "A Phased Implementation Plan for a Procurement Automation System," *ARPANET MANAGEMENT STUDY: New Application Areas*, Cabledata Associates Report #R-148 (First Quarterly Technical Report), (NTIS AD #787039), May 1974.

These systems can play a helpful role in the development of an integrated procurement network. Therefore, their development, characteristics, and capabilities are of importance.

To date, these systems have experienced some difficulty in achieving DoD-wide integration.* It is precisely this difficulty which revealed the lessons and conclusions embedded in the text of the final report.

CONCLUSION OF SURVEY

The overriding conclusion of this field survey is that the DoD has already developed an impressive array of automation capabilities, both in equipment acquisition and organizational and manpower development.

A few key elements are still missing. The procurement automation effort as described in this volume is designed to meet these omissions, to capture the experiences and lessons of previous efforts, and to slightly extend the state of the art.

The key point to be emphasized is that the proposed system is really an extension to be built onto, or augment, existing capability. It is not intended to replace an old working mousetrap with a shiny new one. The best features of current systems, of course, should be retained and updated. What is sought is a blueprint for the next stage evolution of improvements of management tools for government procurement.

----
*
See, in detail, *Management Review of Contract Administration & Materiel Acquisition Information Systems*, March 1974, published by the Office of the Assistant Secretary of Defense for Installation and Logistics. The report, directed on 15 June 1973, was conducted by a review team consisting of members of OSD, Army, Navy, Air Force, and DSA. In particular, personnel involved in procurement automation were included.